SYSTRON DONNER

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SYSTRON DONNER
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HHB SERIES

POWER SUPPLIES

INSTRUMENT DIVISION

OPERATING AND SERVICE MANUAL

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SYSTRON DONNER
INSTRUMENT DIVISION
2727 Systron Drive
Concord, California 94518

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A The warranty period will be one year from the date of shipment. This warranty is extended only to the original buyer.

III Warranty Adjustments

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B Systron Donner agrees to repair or furnish a replacement for, but not install, any product which within the standard warranty shall, upon test and examination by Systron Donner, prove defective within the above warranty period.

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D The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than Systron Donner; by persons not expressly approved by Systron Donner; not to any unit, the serial number of which has been removed or defaced or Changed.

E This warranty applies to new equipment only and will cover repaired or replacement items only to the extent of the balance remaining of the items original warranty period noted in Paragraph II.

F All freight charges will be paid for by the Purchaser.

June, 1985

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CHAPTER 1

GENERAL INFORMATION

1.1 INTRODUCTION

The HHB Quarter Rack Series Power Supplies are a flexible and dependable source of dc power, which can be used to meet a variety of needs. These needs may range from inspection and production testing, to laboratory bench testing and systems applications. Their quarter rack size and wide range of outputs allow them to be used individually or configured into multiple output packages of two, three, or four units in minimum space with high reliability for constant voltage/constant current requirement. The high quality standards permits a five year warranty. This instruction manual contains general characteristics and specifications, operating procedures, theory of operation, maintenance and calibration, parts list and related schematic diagrams for the Models HHB 6-5, HHB20-2, HHB 50-1 and HHB 150-300.

1.2 DESCRIPTION

These units are lightweight, compact and versatile precision dissipative regulators housed in a quarter rack chassis. Constant voltage and constant current operation is provided with automatic crossover from one mode to the other. In the voltage mode, adjustable current limiting is provided while the current mode provides adjustable voltage limiting. Both voltage and current are metered. In addition, an LED mode indicator on the front panel indicates when the unit is operating in the constant current or current limiting mode. Features include floating output, remote sensing, remote voltage programming, +55°C operation without derating, series or parallel operation, no turn on/off transients, optional overvoltage protection and built-in automatic current protection. Output, sensing, and remote programming terminals are located on a rear panel mounted barrier strip. The ac power switch with ON indicator lamp, current mode indicator, current and voltage meters and controls are all located on the front panel. For added convenience, additional output terminals (binding post post) +V, -V and GND are also provided on the front panel.

Constant Voltage Mode.

A constant voltage is maintained across the output terminals at any preset value from zero to rated output voltage, provided that the load does not draw more than the preset limiting current value determined by the front panel current control setting.

Remote programming is provided and may be utilized over the entire range of the unit.

Constant Current Mode.

Constant current is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic crossover network changes the mode of operation from constant voltage to constant current when the current demand reaches that of the preset current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions and occurs at a critical value of load resistance R_C=Es/Is, where Is is the front panel voltage control setting and Is is the front panel current control setting.

1.3 SPECIFICATIONS

Table 1-1 is a complete list of the standard specifications and the optional overvoltage specifications.

TABLE 1-1 SPECIFICATIONS

Input:	Internal taps for: 90-110V ac; 104-127V ac; 194-237V ac and 207-237V ac @ 47-440 Hz.			
Input Power:	HHB6-5 84W	HHB20-2 74W	HHB50-1 77W	HHB150-300 64W
Output:	May be floated up to 300V dc maximum above ground. Voltage is settable front panel controls from 0 to rated output. Current is settable from 5% to rated output.			

TABLE 1-1 SPECIFICATIONS (Cont)

Output: (Cont)		Volts	Amps	Impedance*
	HHB6-5	0-6	0-5	0.0001
	HHB20-2	0-20	0-2	0.0005
	HHB50-1	0-50	0-1	0.0025
	HHB150-300	0-150	0-0.3	0.025

*Nominal dc to 1 kHz

Constant Voltage Mode With Adjustable Current Limiting

Source Effect (Line Regulation):	0.001% or 100 μV, whichever is greater, for ±10% line change at any output within specifications.
Load Effect (Load Regulation):	0.005% or 200 μV, whichever is greater, for no load to full load at any output within specifications.
PARD (Ripple & Noise):	200 μV rms; 2 mV p-p 20 Hz to 10 MHz.
Time Effect (Stability):	8 hours drift after 30 minutes warm-up constant line, load and temp. 0.01% or 1 mV whichever is greater.
Temperature Effect: (Temp. Coefficient)	0.01% output change per °C over operating range.
Temperature Range:	0°C to +55°C operating. -40°C to +85°C storage.
Load Effect Transient Recovery Time:	<50 μsec. To within load effect band or 2 mV whichever is greater for any change within the current rating of the unit.
Resolution:	<0.02% of full scale.
Programming Coeffiecient:	1 volt/volt remote voltage. 1 kΩ/volt remote resistance except HHB 150-300: 750Ω/volt remote resistance.

Constant Current Mode With Adjustable Voltage Limiting

Voltage Compliance:	0 to output rated voltage.
Current Output:	<5% to rated current.
Source Effect: (Line Regulation)	0.05% for 10% line change.

TABLE 1-1 SPECIFICATIONS (Cont)

Load Effect: (Load Regulation):	<5 ma over full voltage compliance.
PARD (Ripple & Noise):	2 mA rms, 5 mA p-p 20 Hz to 10 MHz.
Time Effect: (Stability)	8 hours drift after 30 minutes warm-up constant line, load and temp. 0.1% or 1 mA whichever is greater.
Temperature Effect: (Temp. Coefficient)	0.01% output change per °C over operating range.
Resolution:	<0.5% of full scale after calibration.

General And Physical Specifications

Design Principle:	Precision Series Pass Regulation.
Operational Mode:	Constant voltage with adjustable current limiting; constant current with adjustable voltage limiting; automatic crossover.
Mode Indicator:	Front panel LED indicates when supply is operating in the constant current or current limiting mode.
Panel Meters:	Separate panel meters for voltage and current; readings are accurate to ±3% of full scale.
Controls:	
Voltage:	Front panel ten turn voltage adjust from 0 to rated output. Full scale voltage calibration adjustment accessible from the rear panel.
Current:	Front Panel 1 turn current control adjust from <5% to rated output.
Input Power:	Front panel switch with "power on" indicator.
Terminals:	
Front Panel:	+V positive output binding post; -V negative output binding post; and GND binding post.

TABLE 1-1 SPECIFICATIONS (Cont)

Rear Panel:	Barrier strip with -V negative output; -S negative sensing; remote voltage programming terminals; +S positive sensing; +V positive output; and G ground.
Overvoltage Protection:	Option 01. Fast acting adjustable overvoltage crowbar circuit latches the output voltage. Available as an option for the 6V, 20V and 50V units only.
Setability:	Minimum trip adjustment range is 4.7V (5.2V HHB 50-1) to ≈110% of rated voltage.

TABLE 1-1 SPECIFICATIONS (Cont)

Threshold:	Recommended minimum margin of setting is 5% V-rated or 0.5 volts whichever is greater.
Response:	<50 μsec. required for crowbar action.
Temperature Effect:	0.1% per °C after 30 minute warm-up.
Dimensions:	5.38"H X 4.25"W X 16.0"D (137 mm H X 108 mm W X 406 mm D).
Weight:	11 lbs. (5kg) net; 15 lbs. (6, 8 kg shipping.

CHAPTER 2

INSTALLATION AND OPERATION

2.1 INTRODUCTION

The HHB Series Power Supplies are shipped in operational condition and are ready for use as received. This chapter outlines the procedures for initial inspection, installation and operation of the unit. Instructions for reshipment are also included should the unit be returned to Systron-Donner for service or repair.

2.2 RECEIVING INSPECTION

Prior to accepting the unit from the shipper, inspect the condition of the shipping container for any indication of freight damage. Any sign of such damage must be noted by both the shipper and receiver and should be reported to the insurance investigator.

Immediately following removal of the instrument from the shipping carton, inspect for possible physical damage incurred during shipment. Check surfaces for scratches or dents and note condition of controls and connectors. Should any damage be noted, notify your nearest Systron-Donner representative - - - DO NOT USE THE POWER SUPPLY UNTIL INSTRUCTED TO DO SO BY THE REPRESENTATIVE.

2.3 RESHIPMENT

When the instrument is to be repackaged for shipment use the original packing materials. Your Systron-Donner field-office can provide materials similar to those used for the original factory packaging, or repackage the instrument following these general instructions.

General packaging instructions:

1) Attach a tag to the unit indicating the model number, serial number, name and address of the instrument owner, and a summary of the service or repairs required.

2) Wrap the instrument in heavy paper or plastic prior to placing it into the shipping container.

3) Select a strong carton or wooden box to house the instrument.

4) Use an adequate layer of shock-absorbing material on all sides of the instrument and protect the front panel with additional layers of cardboard. Be certain that there is no movement of the unit within the container.

5) Seal the package with strong tape or metal bands.

6) Mark the shipping container "FRAGILE-DELICATE INSTRUMENT" to ensure careful handling.

7) Be certain that all correspondence refers to full instrument nomenclature (model and serial number).

2.4 POWER REQUIREMENTS

The HHB Series Power Supplies are equipped with a standard three-conductor power cord which when plugged into an appropriate power receptacle, grounds the unit to protect operating personnel from certain electrical hazards. Whenever the power cord is mated to a two-conductor outlet, a cord adapter plug (properly installed) will provide the same protection.

The instrument operates from an ac power source and by appropriate connection of internal taps from either 90-110, 104-127, 194-237, and 207-253 at 47-440 Hz. Power consumption varies for each model as described in the specifications. Unless requested otherwise, the instrument is normally factory wired for 104-127V ac. Prior to operation insure the unit is wired for the correct line voltage application. To change operating voltages remove the connections to T101 and rewire in accordance with the transformer connections depicted

on the chassis assembly schematic diagram.

A heavy duty 3-wire line cord with molded NEMA style 5-15P plug provides input power. The power handling ability of the ac lines feeding ac power to the line cord must be considered, as serious losses in regulation and substantial increases in ripple can occur as a consequence of insufficient power handling capacity of these lines. The ac impedance from the breaker box to the power supply input connector should not exceed 0.75 ohms. All ac power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of empedance producing oxide coatings.

2.5 OUTPUT CONNECTION

Output voltage is available from either the front or rear panel. However, while regulation is maintained at both terminals, the rated regulation is available from the rear panel terminals only. The front panel output consists of binding post for +V and -V and GND. A nine terminal barrier strip mounted on the rear panel provides output, sensing, programming and ground connections.

Shorting Link Application. The power supply is shipped from the factory with shorting links in place across terminals 1, 2 and 3; +V and +S; and -V and -S. In this configuration, and with a load connected to the rear panel output terminals, local sensing and programming operation from the rear panel is provided. If terminals +V and +S or unregulated. Refer to operating procedures for specific shorting link applications. Table 2-1 lists the more common shorting link applications.

2.6 OPERATION

The unit is adjusted to rated current and voltage outputs at the factory. The front panel contains the power switch, a ten turn voltage control and a single turn current control for local operation. A full scale voltage calibration potentiometer is accessible (screw driver adjust) from the rear panel. On those units equipped with overvoltage Option 01, the OV trip point is also accessible (screw driver adjust) from the rear panel. All internal control settings are factory preset and require no additional adjusting. However, if it should become necessary to adjust any internal control, due to circuit changes caused by component aging and or replacement, refer to the calibration chapter for complete details.

TABLE 2-1 SHORTING LINK APPLICATION

Terminals	Condition	Function
-V and -S +V and +S	Shorted Shorted	Local sensing and regulation at rear panel output terminals.
-V and -S +V and +S	Links open. Sense leads connected to load.	Remote sensing and regulation at rear panel output.
RVP 1,2 & 3 4	Shorted Open	Voltage programmed locally, output dependent upon front panel control settings.
RVP 1 & 2 2 & 4 3	Shorted Ext. Program Resistor Open	Voltage programmed remotely, output dependent upon size of external program resistor.

Notes: If V or S lines remain open, rated output can not be maintained. The unit must be operated with S leads connected, however, built-in circuitry will protect the unit from damage should an S lead open.

2.6.1 Power On

Set all front panel controls full CCW. Ascertain that the shorting links are positioned as appropriate for local or remote sensing, local or remote voltage control. Either side of the output may be grounded, or the output may be used in a floating condition. As soon as the power switch is set ON the unit is ready for use. However, a 30 minute warm-up is recommended to reach rated stability.

Constant Voltage Operation With Current Limiting. The voltage stability of the power supply enables the output voltage to be set precisely to any output within it's rated range. Monitor the respective output voltage on the front panel voltmeter, or via a DVM attached to the appropriate front panel binding post, and adjust the front panel voltage control for the required output. Adjusting

for maximum current required is also via the front panel current control and current meter. With a short circuit across the output adjust the current limit control for the required maximum current output.

Constant Current Operation With Voltage Limiting. All instruments provide constant current operation automatically and indicate while in a constant current mode by the I LED indicator. The value of the constant current is set by the front panel CURRENT control. The minimum limit for constant current control is ≈5% of rated current, however, particular care must be taken when the instrument is subject to the smaller output currents, since the charging or discharging currents of the output capacitor affect the constant current depending on the charging condition of the output capacitor under dynamic loading conditions.

The output voltage is adjusted by the voltage control subject to a no load condition.

2.6.2 Remote Sensing

Unavoidable voltage drops across the output terminals and the load lines can be compensated by including sensing leads in conjunction with the load, noting however, that a voltage drop of 0.5V per lead must not be exceeded.

Circuit Arrangement Remote Sensing.
Open the link between +V and +S and -V and -S on TB101. Connect the ±S leads between TB101 and the load. Long sensing leads should be a shielded twisted pair.

NOTE

When operating the power supply with the sense leads opened, rated data cannot be maintained, however, instruments are protected so that no damage is experienced even with an S-lead open.

2.6.3 Remote Voltage Programming

Remote voltage programming can be accomplished by either remote voltage or remote resistance programming methods using the RVP 1-2-3-4 terminals on TB101.

Note: 1. When the programming line is interrupted during operation, the output voltage increases to the maximum possible unregulated dc.

2. When using long programming leads it is a good practice to shield the leads (shielded twisted pair), to minimize noise and or inductive pick-up, with one end of the shield grounded to the power supply and the other end open.

3. Programming speed at which the output voltage responds to a change of adjustment depends on such variables as load impedance, output capacity, programming element response time, direction and amount of change. Response can thus vary as a factor of these parameters.

The following three examples are provided to show the different remote programming techniques that may be used. Voltage programming techniques are not limited to the following examples and may be varied for different applications (refer to the Power Supply application notes for detailed description of remote voltage programming).

2.6.3.1 Voltage Programming With Voltage Control

The power supply output voltage can be controlled remotely with an input voltage. When using this programming technique the power supply becomes in effect a low frequency dc amplifier.

Two distinct methods can be employed to voltage program: unity and variable voltage gain.

Figure 2-1 depicts the configuration for unity (1:1 ratio) voltage gain. A voltage source such as a battery or DAC is connected between the -S and RVP-2 terminals. This voltage source must be free of any PARD or other undesired imperfections, since within the regulation bandwidth of the power supply any PARD will be reproduced on it's output terminals.

If the load (R_L) is located any distance from the power supply the sensing leads (+S and -S) should

be a shielded twisted pair, with the shield grounded at the power supply and the load end of the shield left open.

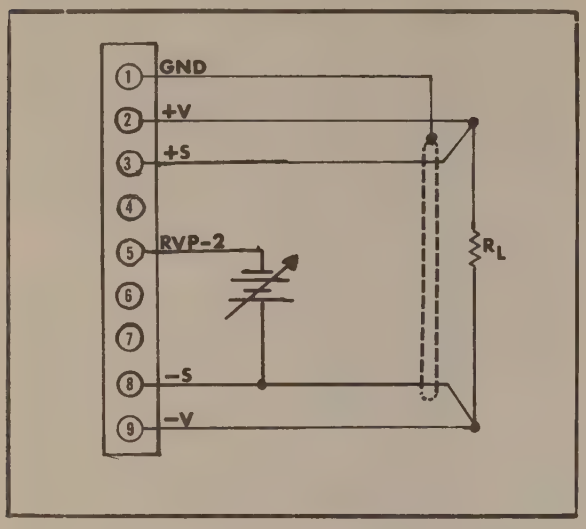


FIGURE 2-1 UNITY GAIN VOLTAGE PROGRAMMING OF OUTPUT VOLTAGE

Figure 2-2 depicts the configuration for variable voltage gain. A battery, low impedance operational amplifier or a DAC may be utilized for the voltage source. The gain of the power supply is determined by the ratio of the feedback resistor (R_f) to the input resistor (R_i), $\frac{Rf}{Ri}$

Resistor R_f can be selected so that the resulting voltage gain is either less or greater than unity. These resistors should have a temperature coefficient of $\leq$20 ppm/°C and a conservative wattage rating ($\geq$0.5 watts) in order to minimize any temperature effect.

If the load (R_L) is located any distance from the power supply, a shielded twisted pair should be used for the sensing leads.

2.6.3.2 Voltage Programming With Resistance Control

The power supply output voltage can be controlled by a remote programming resistor. Figure 2-3 depicts the configuration for external resistance programming. The external resistance method in effect, replaces the front panel and internal voltage

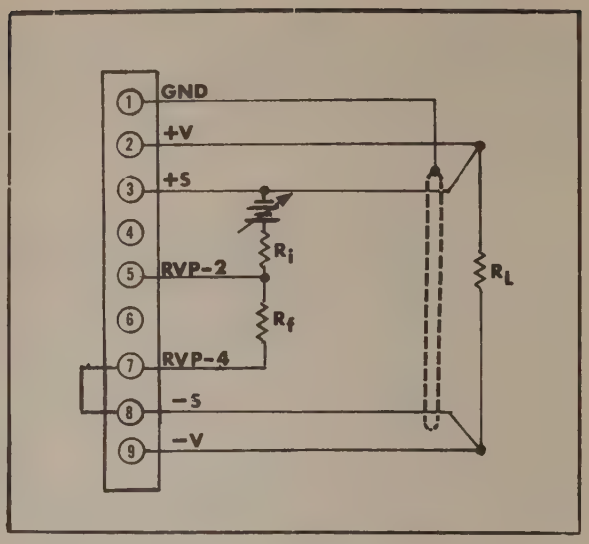


FIGURE 2-2 VARIABLE GAIN VOLTAGE PROGRAMMING OF OUTPUT VOLTAGE

control potentiometers. The external programming resistor (Rp) provides a 1 kΩ/volt ratio for programming the HHB 6-5, HHB 20-2 and the HHB 50-1 power supplies. When programming the HHB 150-300 a 750Ω/volt ratio is utilized.

Terminal RVP-1 provides a constant current source for the external programming resistor (Rp). The current through Rp corresponds to the inverse of the programming ratio i.e. 1 kΩ/V=1 mA and 750Ω/V=1.33 mA.

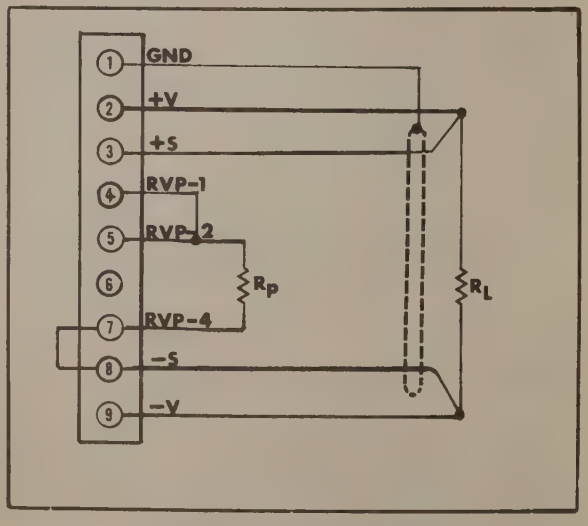


FIGURE 2-3 RESISTANCE PROGRAMMING OF OUTPUT VOLTAGE

The programming resistor used should have a temperature coefficient of ≤20 ppm/°C and a wattage rating of ≥0.5 watts to minimize any heating effect.

If the load (R_L) is located any distance from the power supply the sensing leads (+S and -S) should be a shielded twisted pair, with the shield grounded at the power supply and the load end of the shield left open.

2.6.4 Series Operation

Two or more instruments may be operated in series to obtain higher voltages than normally available from a single supply.

An example of two supplies connected to achieve series operation is shown in Figure 2-4. Each supply should have it's +V, +S, and -V, -S terminals jumpered as shown. These terminals should be removed from chassis ground.

When two or more supplies are connected in series it is not advisable to operate at voltages greater than 300 volts, thereby avoiding the possibility of capacitor and insulation breakdown. Normal current regulation and limiting may be achieved by setting the current adjust control on each supply to the desired value.

To prevent ripple and circulating ground currents, it is advisable to connect the chassis ground terminals together.

Note that the ± sense and voltage terminals are connected together in a series configuration and only one of the common voltage terminals is connected to it's sense terminal. This is done to insure that the rated voltage regulation is maintained at the load. Each unit within the series string is adjusted independently and must be adjusted accordingly. The output voltage being equal to the sum of the respective voltage settings.

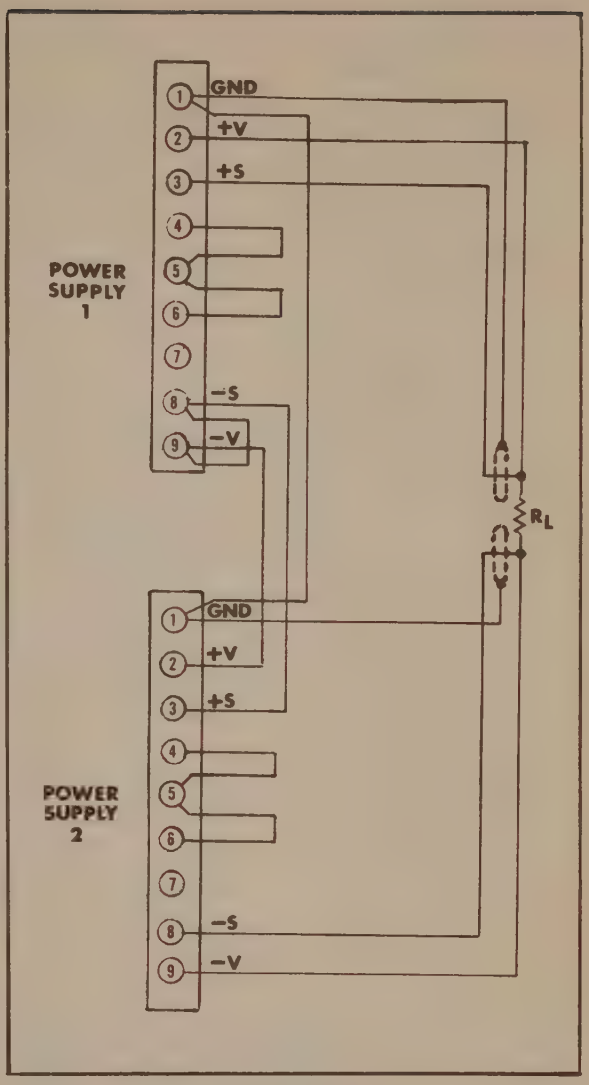


FIGURE 2-4
SERIES OPERATION CONFIGURATION

2.6.5 Parallel Operation

Two or more power supplies may be connected in parallel when a greater current than that obtainable from one supply is required. These supplies need not be of the same ratings however they should be equipped with automatic or foldback current limiting. Current limiting prevents damage to the supply by large circulating currents resulting from any difference in voltage. Most Systron-Donner supplies contain current limiting with automatic crossover features and are suitable for direct paralleling operation.

The two supplies to be paralleled should be set to approximately the same voltage and their respective plus and minus voltage terminals connected together. Current to the load will be drawn from the supply that is set to the highest voltage until

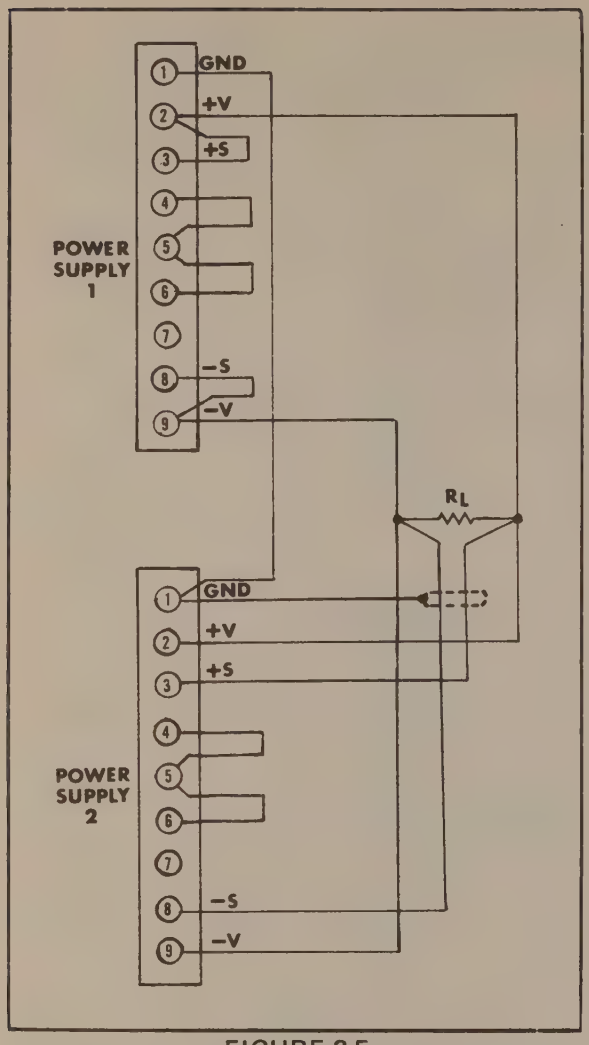


FIGURE 2-5
PARALLEL OPERATION CONFIGURATION

it goes into current limiting and it's voltage decreases to that of the second supply at which time the second supply will contribute to the current demand. Regulation of the combination will, naturally, be affected by any difference in setting of the two supplies.

To achieve remote sensing, in parallel connected supplies, connect the sense leads of the lower voltage supply to the load.

The inherent load regulation of the parallel connected supplies is equal to the nominal regulation of the individual supply plus the difference between the nominal voltage setting of the two supplies.

When parallel connected supplies are used in systems application, it is advisable to turn-on both units simultaneously. The inputs to both supplies should be connected to a single circuit breaker.

When two supplies are operated in parallel it is not advisable to set either voltage control near zero since this would cause severe damage to the control.

In parallel operation, supplies equipped with overvoltage protection, only one OV circuit should be active. Normally, the supply set to the highest voltage. Set the OV control to maximum in the lower voltage supply.

2.6.6 Master-Slave Bipolar Tracking Operation

Master-Slave operation of power supplies will permit equal or proportional voltage sharing under all rated load conditions with control of the output voltages controllable by the designated Master power supply. Figure 2-6 depicts the relative hookup for Bipolar Tracking operation.

The Slave power-supply is connected in series with the negative output of the Master power supply. A voltage divider network, R_i R_f, is placed across the total output terminals in series. The inputs of the slave comparison amplifier are taken at the junction of R_i R_f. Since the Slaves normal feedback action is to maintain a zero error between the comparison amplifiers inputs, the slave supply will adjust itself to contribute to the fraction of the total output as determined by the R_i R_f divider network. Adjusting the voltage control on the master power supply will result in a continual variation of the total series output.

2.6.7 Overvoltage Option 01 Operation

On those units with Option 01 installed, the OV setting is normally adjusted at the factory for ≈110% of V rating. Should an alternate OV setting be required, adjust the output voltage to the desired OV value and rotate R203 (rear panel O.V. ADJ.) counter clockwise until OV trips. Output voltage should go to less than 1 volt and no current on the current meter. Minimum trip adjustment is 4.7 volts for 6-5 and 20-2 models and 5.2 volts for 50-1 model.

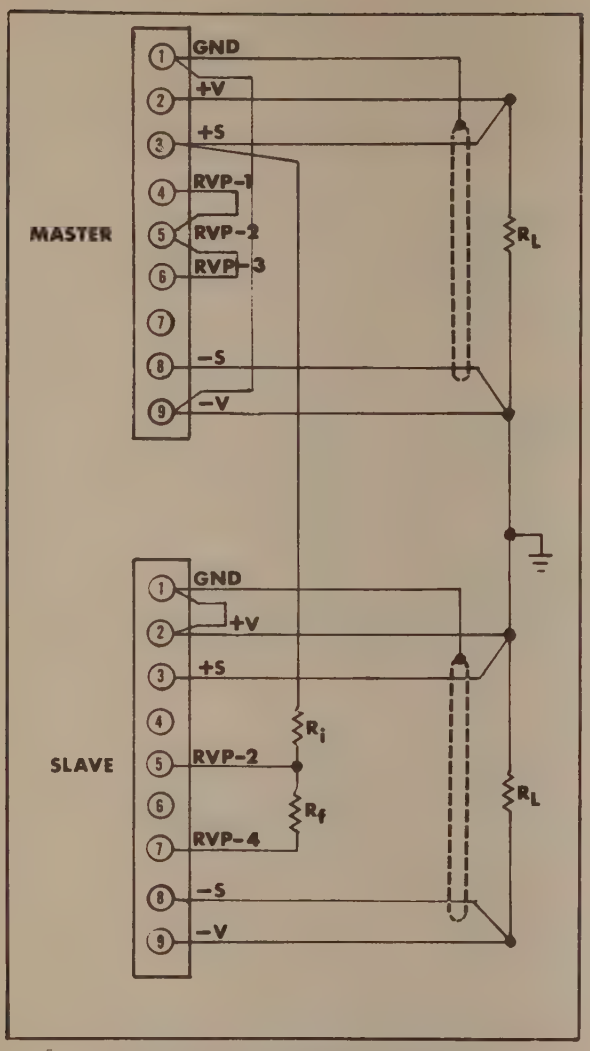


FIGURE 2-6 MASTER-SLAVE BIPOLAR TRACKING CONFIGURATION

To reset the OV circuitry once it is tripped, the supply must be turned off for a minimum of 5 seconds and then turned on.

CHAPTER 3

PRINCIPLES OF OPERATION

3.1 HHB SERIES FUNCTIONAL DESCRIPTION

The following functional description is referenced to Figure 3-1 HHB Series Functional Schematic Diagram, which depicts the Power Supply in a simplified form. Detailed schematic diagrams located in Chapter 6 of this manual further support the circuit analysis of the Power Supply.

Figure 3-1 depicts the rear panel barrier strip shorting links W4 through W7 and the internal primary power transformer jumpers W2 and W3 in the "as shipped" configuration. This configuration provides 104 - 127V ac input power, local sensing and local control of the output voltage and current limiting functions. The following circuit analysis is thus structured to this "as shipped" configuration.

Reference designators assigned to the electronic components are divided into three numerical series, to indicate assembly location or option. Listed below are these reference designator series.

1 - 99	PCB Assembly mounted components.
101 - 199	Chassis, Heatsink, Front and Rear Panel mounted components.
201 - 299	Over Voltage Option related components.

One schematic diagram (7C06524701) supports the PCB and contains selection tables to identify the differences in component values of the four Power Supplies of the HHB series. Four separate schematic diagrams provide the chassis assembly configuration of the four Power Supplies of the HHB series.

The overall function of the Power Supply is to transform and rectify the ac input line voltage into a well regulated, stable, and adjustable dc output. In performing these functions, the circuitry can be broken down into the following subfunctions.

1. Load Rectifier and Filter.
2. Auxiliary Rectifier and Filter.
3. Series Pass Regulator.
4. Auxiliary Regulator.
5. Voltage Comparator.
6. Current Comparator.

3.2 CIRCUIT ANALYSIS

The following circuit analysis is referenced to Figure 3-1 and the schematic diagrams located in Chapter 6.

3.2.1 Primary Input, Rectifiers And Filter Circuits

The input power is obtained through power transformer T101. Full wave rectifier CR101 and CR-102 provides the load rectification and is applied to the series pass regulator circuit located on the heat sink assembly. Capacitor C103 and resistor R102 constitutes the load RC filter. Full wave rectifier CR1 and CR2 provides for the auxiliary regulator rectification and capacitor C3 provides it's filtering function.

When the front panel ac power rocker switch S101 is placed into it's ON position it's internal neon lamp will illuminate, and ac power is applied to the primary of transformer T101. Regulated dc output power is immediately made available at the rear panel barrier strip TB101 +V and -V terminals.

3.2.2 Series Pass Regulator Circuit

The dc voltage from rectifier diodes CR101 and CR102 is directed through the series pass transistors Q101 and Q102. The conduction of thes transistors is controlled by the voltage comparator output (U2 pin 6) which applies the base bias. Conduction of the series pass transistors will vary in accordance with the regulation requirements to increase or decrease the power supply's output.

To dissipate power away from the series, pass circuit when current is not being fed into an external load, a high wattage current handling "throw-off" resistor R103 is connected in parallel with Q101. R103 is located physically on the rear panel assembly to reduce thermal concentration on the heatsink, thus increasing the life and reliability of the series pass transistors.

3.2.3 Auxiliary Regulator Circuit

The rectified and filtered voltage from rectifiers CR1 and CR2 and capacitor C3 is applied to the auxiliary series pass regulator Q2 and the constant current source FET Q1. The conduction of Q1 and Q2 is controlled by IC differential amplifier U1. The auxiliary regulator supplies highly stable reference voltages that are referenced to the +S and +V lines. These reference voltages are listed as follows with their associated zener reference diode.

1. +S +9V CR4
2. +S +15V CR3
3. +V -6.2V CR18

3.2.4 Voltage Comparator Circuit

The voltage sensing and comparison is accomplished by IC differential amplifier U2. A sampling of the output voltage as the +S signal is applied to U2 pin 2. A voltage level that relates to the desired output power supply voltage (set point value) is applied to U2 pin 3. This set point value is set by the front panel VOLTAGE control potentiometer R105, or by remote programming.

If the output voltage of the power supply changes due to loading or input line voltage variation effects, the error (difference between the +S and set point voltage levels) appears as a voltage change at U2 pin 6. This error voltage is then applied to the series pass transistors Q101 and Q102 as base bias.

3.2.5 Current Comparator Circuit

The current comparator circuit provides the constant current mode function or current mode function or current limiting when constant voltage mode function is operational.

The current sensing and comparison is accomplished by IC differential amplifier U3. A sampling of the output current is provided by monitoring the voltage drop across current sensing resistor R22. The output end of resistor R22 is applied to U3 pin 3 as the +V signal. The emitter output of the series pass transistor Q102 is monitored via the front panel CURRENT control R101 and applied to U3 pin 2. The internal I CAL adjustment potentiometer R24 is connected between the +V -6.2V reference and U3 pin 2 to allow for the calibration of the CURRENT control. The voltage differential developed between U3 pin 2 and 3 is the current error, which is amplified to generate the current control signal at U3 pin 6. The output at U3 pin 6 is applied to U2 pin 8 via diode CR7 which provides a variable clamping action to the voltage comparator U2. Which in effect will increase or decrease the conduction of the series pass transistor, thus maintaining a constant voltage across the current sensing resistor R22. When operating in the constant current mode transistor Q3 is bias into conduction via diode CR16, thereby causing the front panel I LED indicator to illuminate.

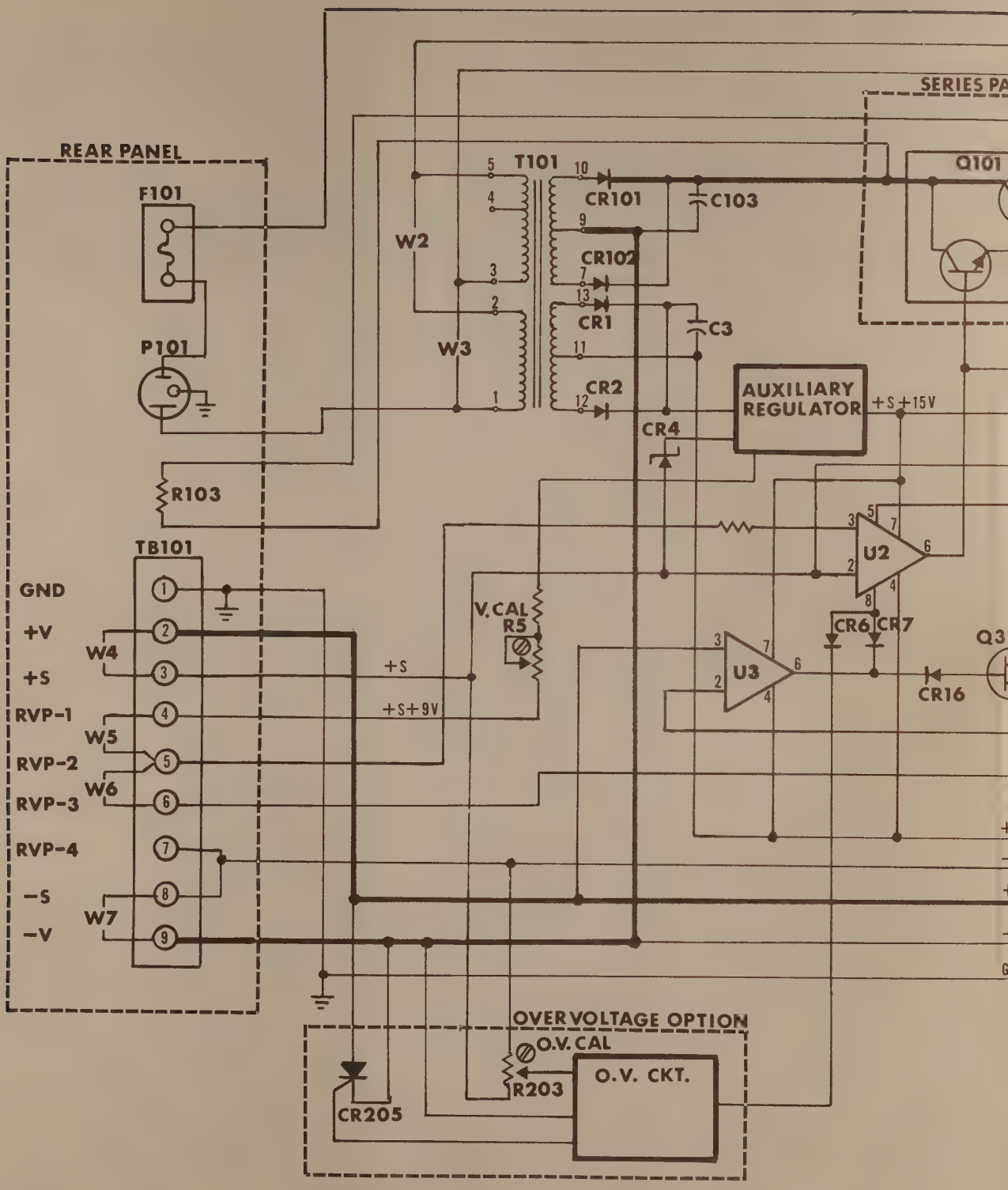
The crossover between constant voltage to constant current mode is automatic. The point at which the operating mode automatically changes as a function of variation of the external load and occurs at a critical value of load resistance $R_L = E_S/I_S$, where E_S is the front panel VOLTAGE control setting and I_S is the front panel CURRENT control setting.

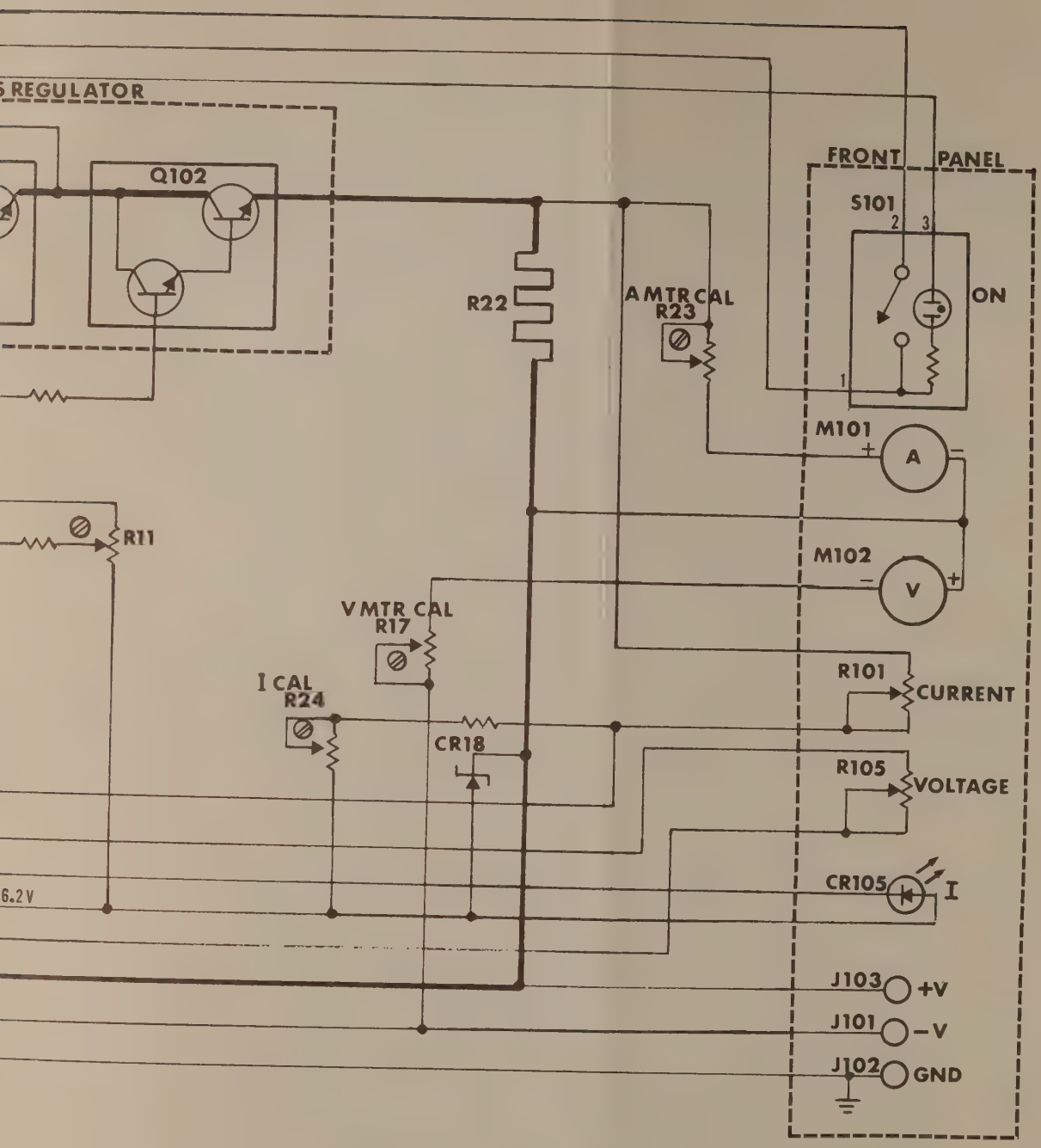
3.3 OPTIONAL FEATURES

Option 01 Overvoltage Protection is provided for the HHB 6-5, HHB 20-2 and HHB 50-1 Power Supplies.

3.3.1 Overvoltage (OV) Circuit

The overvoltage protection is provided to protect the load or the Power Supply itself from overvoltage transients or regulation failure. The voltage across the Power Supply's output is sensed and if it rises above the protection voltage threshold set by potentiometer R203, the output of the Power Supply will be "crowbarred" by the firing of SCR CR205.


REAR PANEL
F101
P101
R103
TB101
GND
+V
+S
RVP-1
RVP-2
RVP-3
RVP-4
-S
-V
W4
W5
W6
W7
T101
W2
W3
CR101
CR102
CR1
CR2
C103
C3
CR4
AUXILIARY REGULATOR
+S+15V
SERIES PA
Q101
U2
U3
CR6
CR7
CR16
Q3
V. CAL R5
+S
+S+9V
OVER VOLTAGE OPTION
O.V. CAL
R203
O.V. CKT.
CR205



MODEL HHB SERIES

FUNCTIONAL SCHEMATIC DIAGRAM

CHAPTER 4

MAINTENANCE AND CALIBRATION

4.1 INTRODUCTION

This chapter provides information on alignment and calibration procedures, routine maintenance, and troubleshooting techniques.

Whenever the Power Supply requires factory service, the nearest Systron-Donner representative should be contacted. He can provide field service at your location or arrange factory return when necessary. Address all inquiries on operation service or application to your nearest Systron-Donner Service Division Center or the National Service Center. Specify the model and the complete serial number in all correspondance.

4.2 TEST EQUIPMENT

Table 4-1 lists the test equipment required for the test and calibration procedures. Alternate test equipment with equivalent characteristics may be used when the recommended types are not available.

TABLE 4-1
RECOMMENDED TEST EQUIPMENT

Oscilloscope Tektronic 5000 Series	2 MHz BW 1 mV/Div Differential Input w/5A 13N Plug-in.
Digital Multimeter Systron-Donner 7004	ac and dc voltage and current ±.01% 4 1/2 digit.
Variable Auto- transformer (Variac) Powerstate 3PN136	0 - 140V ac 100 watts.

4.3 INTERNAL ADJUSTMENTS AND TEST POINT LOCATION

All adjustments are performed via six potentiometers located on the PCB assembly. Potentiometers R5 (V-CAL) and R203 (O.V. CAL) are accessable via rear panel adjustment ports. Potentiometer R11, R17, R23 and R24 are accessable from the left side of the power supply when the cover is removed. Figure 4-1 depicts the adjustment potentiometers and the test points as to location, function and reference designator.

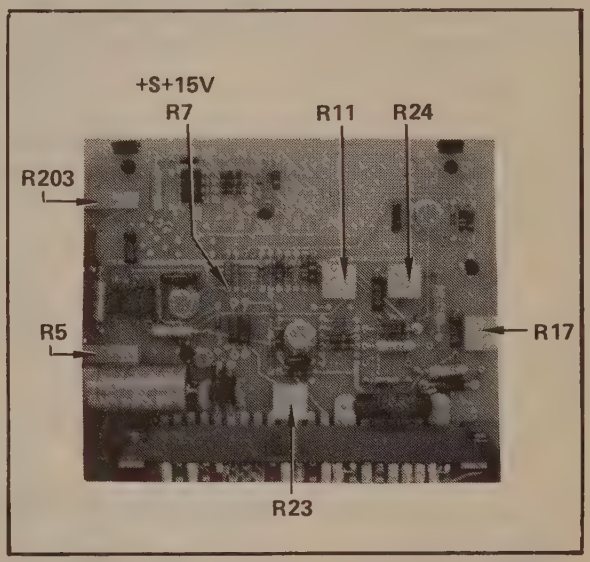


FIGURE 4-1
ADJUSTMENT AND TEST POINT LOCATION

4.4 TEST AND CALIBRATION PROCEDURES

1. Insure that the shorting links are connected on the rear panel barrier strip TB101 for local sensing and local programming as follows:

LINK	TB101 Pins
W4	2 and 3
W5	4 and 5
W6	5 and 6
W7	8 and 9

2. Insure that the primary of transformer T101 is configured for 104-127V ac operation as follows:

JUMPER	T101 Taps
W2	2 and 5
W3	1 and 3

And that the lead from the front panel power switch S101-1 is connected to T101 tap 5.

3. Preset the front panel VOLTAGE control fully CCW and the front panel CURRENT control 1/3 CW. Mechanically zero the V and A meters via their front panel adjustment slots.

4. Apply line power to the rear panel connector via a 0 - 140V ac Variac. Connect a DVM across the +S and -S terminals on TB101. Place the front panel power switch to it's ON position and verify that the power switch internal neon lamp illuminates.

5. Slowly run up the variac, while observing the DVM. The DVM should indicate a zero ($\leq$0.1V) output. If the output voltage starts to come up, immediately run down the variac and clear the fault before continuing.

6. Run up the variac to 115V ac and measure the voltage of the +S +15V reference at junction of U1 pin 7 and R7, verify that it is 15V ±0.6V; with a Oscilloscope verify that the ripple on the +S +15V reference is $\leq$0.75 mV p-p.

7. With the input at 115V ac measure the voltage across filter capacitor C103 and verify it as to Model as follows:

HHB 6-5	$\approx$16.0V dc
HHB 20-2	$\approx$35.0V dc
HHB 50-1	$\approx$75.0V dc
HHB 150-300	$\approx$200.0V dc

8. Monitor the voltage between the +S and -S TB101 terminals with a DVM. Rotate the front panel VOLTAGE control fully CW. Adjust potentiometer R5 for the following DVM reading as to Model:

HHB 6-5	7.10V dc
HHB 20-2	20.20V dc
HHB 50-1	50.20V dc
HHB 150-300	150.20V dc

9. Adjust the front panel VOLTAGE control CCW for the following DVM reading as to Model:

HHB 6-5	7.00V dc
HHB 20-2	20.00V dc
HHB 50-1	50.00V dc
HHB 150-300	150.00V dc

Then adjust potentiometer R17 for a full scale reading on the front panel Voltmeter.

10. Rotate the front panel VOLTAGE control fully CCW, maintaining pressure on it's stop. Then adjust potentiometer R11 for a DVM reading as near to zero volts as possible.

11. Connect an appropriate resistive load across the rear panel TB101 +V and -V terminals with a current monitoring shunt resistor in series with the load, (refer to Figure 4-2 for test configuration).

12. Rotate the front panel CURRENT control fully CW.

13. Slowly load the Power Supply for it's full rated voltage and current, while monitoring the current with a DVM connected across the shunt resistor and the voltage with a DVM connected across the +S and -S terminals. Adjust potentiometer R24 as necessary to achieve the full rated voltage and current.

14. Adjust potentiometer R23 for a full scale reading on the front panel A meter.

15. Increase the load for a current output of 103% of the Power Supply's rated output.

Model	103% of Rated Output
HHB 6-5	5.15A
HHB 20-2	2.06A
HHB 50-1	1.03A
HHB 150-300	0.309A

16. Carefully adjust potentiometer R24 to achieve a 103% current limit of the rated output. Verify that the front panel I indicator illuminated at approximately the current limit threshold level.

17. Rotate the front panel CURRENT control fully CCW, verify that the output current drops to less than 5% of the rated output of the Power Supply.

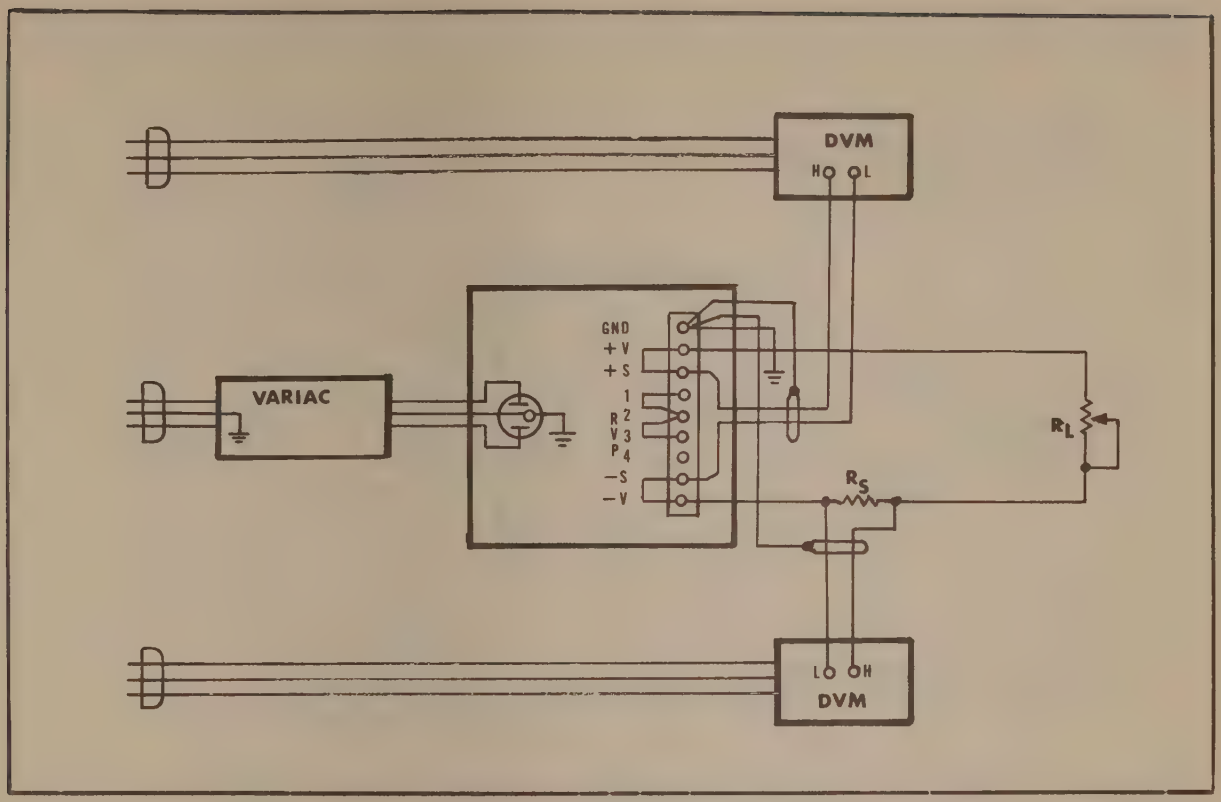


FIGURE 4-2 OUTPUT CURRENT CALIBRATION TEST CONFIGURATION

Model	⩽5% of Rated Output
HHB 6-5	⩽ .25A
HHB 20-2	⩽ .10A
HHB 50-1	⩽ .05A
HHB 150-300	⩽ .015A

18. Configure the Power Supply for constant voltage mode performance test as depicted in Figure 4-3.

19. Load the Power Supply to it's rated output voltage and current. Then vary the line voltage with the variac from 99 to 121V ac and note the output voltage change on the DVM. The source effect for a 10% line voltage change should be ⩽ .001% or ⩽ 100 μV, whichever is greater.

20. Establish 115V ac input line voltage with the variac, switch from full rated load to no load operation, and note the output voltage change on th the DVM. The load effect for no load to full rated load should be ⩽.005% or ⩽200 μV, whichever is greater.

21. Apply rated load to the Power Supply. With an Oscilloscope measure the PARD (ripple and noise) across the +V and -V terminals, it should be less than 2 mV p-p.

22. Configure the Power Supply for the constant current mode performance test as depicted in Figure 4-4.

23. Load the Power Supply to it's rated output voltage and current. Adjust the front panel CURRENT control to place the Power Supply into it's current mode, verify that the front panel I indicator illuminates.

24. Vary the line voltage with the variac from 99 to 121V ac and note the voltage change on the DVM connected across the RS resistor. Calculate the equivalent change of current resulting from the measured voltage change. The Source Effect for a 10% line voltage change should be ⩽ .05.

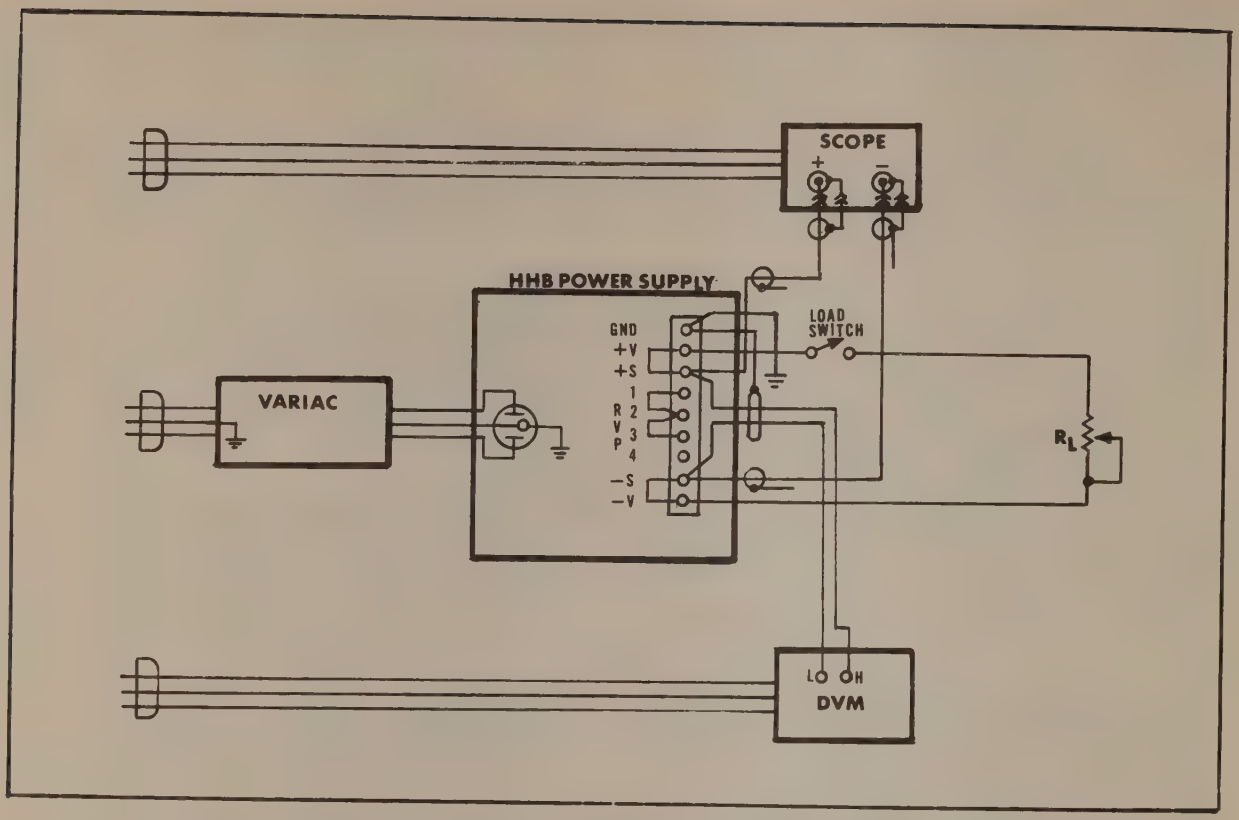


FIGURE 4-3 CONSTANT VOLTAGE MODE TEST CONFIGURATION

25. Establish 115V ac input line voltage with the variac. Switch from load to short circuit and note the voltage change resulting subsequent to the discharge current surge of the internal output capacitor across the R_S resistor. Calculate the equivalent change of current resulting from the measured voltage change. The Load Effect should be <5 ma.

26 With the Power Supply operating in it's current mode at full rating, measure the PARD (ripple and noise) across the R_S with an Oscilloscope. Calculate the equivalent current from the p-p voltage measurement, it should be ≤ 5 mA p-p.

27. Disconnect the test configuration that was installed in step 24.

28. Rotate the front panel VOLTAGE control fully CW.

29. Slowly rotate potentiometer R203 (O.V. CAL) CCW until overvoltage circuit trips. Verify that the output voltage drops to <1V and the current goes to zero. Turn potentiometer R203 one turn CW. Turn off the Power Supply for a period of >5 seconds. Turn on the Power Supply and verify that the voltage returns to it's maximum rated output.

30. With the front panel VOLTAGE control set the output voltage as to Model as follows:

HHB 6-5	4.7V
HHB 20-2	4.7V
HHB 50-1	5.2V

then repeat step 29.

31. Set potentiometer R302 fully CW or to desired O.V. trip point.

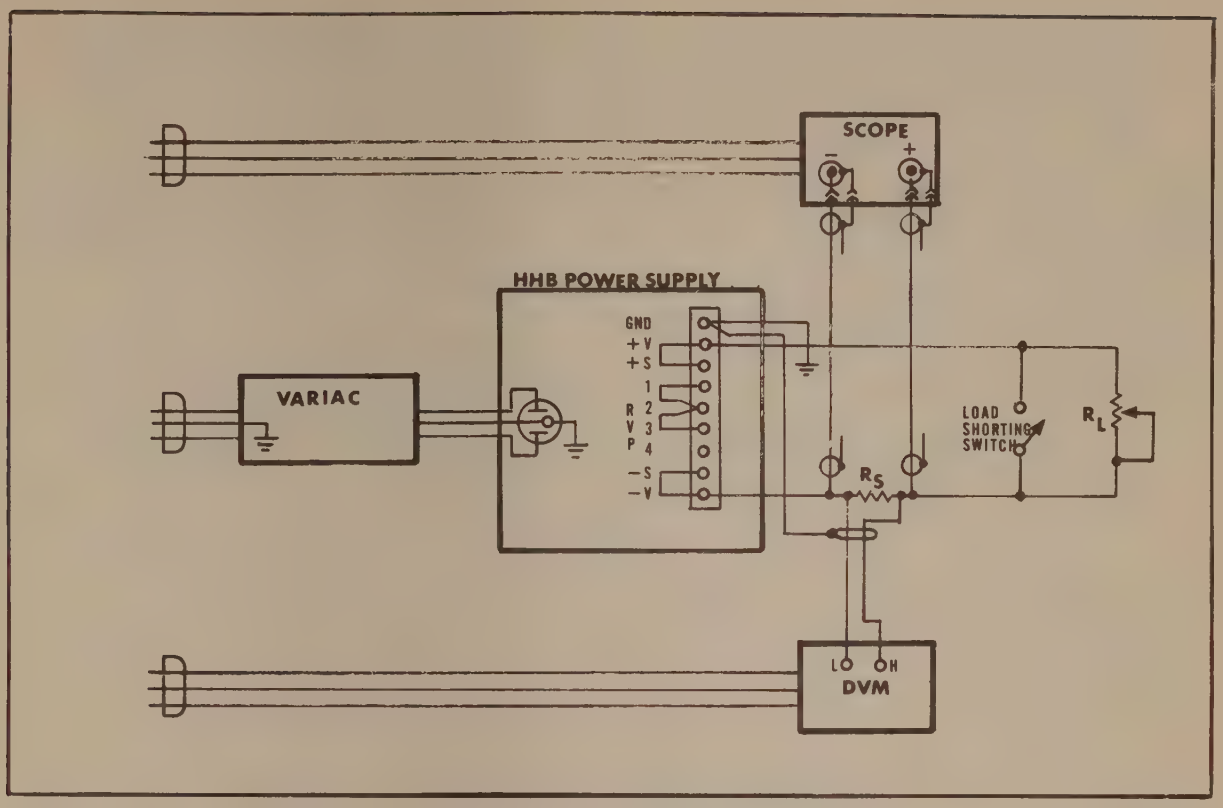


FIGURE 4-4 CONSTANT CURRENT MODE TEST CONFIGURATION

4.5 TROUBLESHOOTING PROCEDURES

If a Power Supply malfunction is indicated the following procedures should be performed to

4.5.1 Loads And Interconnections

To insure that the malfunction is not due to external influences, remove the Power Supply from the system and perform the following procedure.

1. Disconnect all interconnects and loads to which the Power Supply is normally integrated with.

2. Install shorting links on the rear panel TB101 barrier strip as follows:

   TV to +S (terminal 2 to terminal 3)
   RVP-1, RVP-2 and RVP-3 (terminals 4, 5 and 6)
   -S to -V (terminal 8 to terminal 9)

   Insure that these shorting link connections are securely made to prevent any deterioration of regulation.

3. Connect a resistive load across the +V and -V terminals, having the proper ohmic value and wattage rating to provide a maximum rated load to the Power Supply.

Model	Load Resistor
HHB 6-5	1.2Ω 100W
HHB 20-2	10Ω 100W
HHB 50-1	50Ω 100W
HHB 150-3	5Ω 100W

   Insure that the load connections are securely made and that the wiring used is sufficient in gauge to carry the current.

4. Apply nominal ac line power and check for normal operation i.e., rated output and regulation. Proper operation at this time would indicate that any malfunction previously encountered, was external in nature.

5. Check all interconnects, loads, remote programming configurations, shielding and grounding that interfaced with the Power Supply for faults or application errors.

4.5.2 Power Supply Fault Isolation

If the malfunction is determined to be internal to the Power Supply, leave the Power Supply as configured in the preceding procedure, and proceed with the following steps.

1. Rotate the front panel VOLTAGE and CURRENT controls full CW.

2. Using a DVM or a voltmeter having an impedance $\geq 50\ k\Omega/V$ check voltages at the test points or across the components listed in Table 4-2.

3. If voltage checks show no noticable deviations from the prescribed values in Table 4-2, disconnect ac power and proceed with point-to-point resistance checks.

4. If the problem is of an intermittent nature, dynamic changes where noted when making dc voltage checks or high ripple is suspected, the use of an oscilloscope is indicated.

TABLE 4-2 HHB SERIES TEST VOLTAGES

Test Point or Component	Function	Voltage (V dc)			
		HHB 6-5	HHB 20-2	HHB 50-1	HHB 150-300
C103	Output Filter	≈16.0	≈35.0	≈75.0	≈200.
C3	Aux Reg Filter	≈30.0	≈30.0	≈30.0	≈30.0
CR3	Aux Reg Ref Zener	5.6 ± 5%	5.6 ± 5%	5.6 ± 5%	5.6 ± 5%
CR4	+5 + 9V Ref Zener	9 ± 5%	9 ± 5%	9 ± 5%	9 ± 5%
CR18	+V - 6.2V Ref Zener	6.2 ± 5%	6.2 ± 5%	6.2 ± 5%	6.2 ± 5%
CR21	+S + 15V Ref Zener	6.8 ± 5%	6.8 ± 5%	6.8 ± 5%	6.8 ± 5%
CR204	O.V. Opt. Ref Zener	6.8 ± 5%	6.8 ± 5%	6.8 ± 5%	–
CR201	O.V. Opt.	–	–	24 ± 5%	–
PCB pad C to PCB pad 16	+S +9V Ref	9 ± 5%	9 ± 5%	9 ± 5%	9 ± 5%

Note

1. All voltage measurements are normal Power Supply operation 115 volt nominal ac line input full rated output voltage and current.

CHAPTER 5

REPLACEABLE PARTS

5.1 INTRODUCTION

This chapter contains the spare parts lists for each assembly in the HHB Quarter Rack Series Power Supplies. Chapter 6 shows the assemblies where the listed parts are installed. Ordering information is included and should be used when purchasing parts from the factory. Explanation of the column listings and Table 5-1 Manufacturers Code-To-Name Index are also included.

5.2 PART ORDERING INFORMATION

To order a part from the Replaceable Parts List, state the Systron-Donner part number, indicate the quantity required and address the order to the nearest Systron-Donner sales or service center.

To order a part not listed in the Replaceable Parts List, state the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Systron-Donner sales or service center.

5.3 PARTS LISTS

Table 5-1 gives the code-to-name information for the manufacturers listed in the replaceable parts lists. The replaceable parts lists are placed in top assembly breakdown order.

Each column in the parts lists provide specific information relating to the listed parts as follows:

(1) DESIGNATOR: Item and Reference numbers applicable to assemblies are listed in item number, when applicable or alpha-numeric order when listed by reference designator.

(2) The USED ON column lists the different power supply models by code numbers 1 through 4. Components common to all models are coded 1 - 4 whereas a component used only on the HHB 6-5 is coded 1. A breakdown of the used on code appears at the bottom of each parts list.

(3) COMPONENT NOMENCLATURE AND DESCRIPTION: Component names and specifications are provided in these columns and include; values, tolerance, wattage rating, working voltage, construction, etc.

(4) MANUFACTURER'S CODE: H4-2 Federal Supply Code numbers are listed to identify component manufacturers. A Manufacturers Index is provided in this chapter for cross-reference.

(5) MANUFACTURER'S PART NUMBER: True manufacturer part numbers are listed in this column.

(6) SD STOCK NUMBER: The Systron-Donner stock number is listed in this column.

(7) T/Q (Total Quantity): This quantity, appearing after an item entry, indicates the number of times the component is used in that assembly. The total quantity for each part is given only once at the first appearance of the part number in the list.

TABLE 5-1. MANUFACTURER'S CODE-TO-NAME

Code	Name & Address
01121	Allen-Bradley Co. 1201 So. 2nd Street Milwaukee, WI 53204
02735	RCA Corp. Solid State Division Route 202 Somerville, NJ 08876
03508	General Electric Co. Semiconductor Products Dept. Electronics Park Syracuse, NY 13201
03877	Transitron Electronic Corp. 168 - 186 Albion Street Wakefield, MA 01880
04713	Motorola Semiconductor Prod. Inc. 5005 E. McDowell Road Phoenix, AZ 85008
05574	Viking Industries Inc. 21001 Nordhoff Chatsworth, CA 91311
05828	General Instrument Corp. Electronic Systems Division 600 W. John Street Hicksville, Long Island, NY 11802
06776	Robinson Nugent Inc. P.O. Box 470 New Albany, IN 47150
06915	Richco Plastic Co. 5825 N. Tripp Avenue Chicago, IL 60646
07263	Fairchild Camera & Instrument Corp. Semiconductor Division 313 Frontage Road Mountain View, CA 94040
08547	R. G. Wallace Co. Inc. 2301 E. Del Amo Blvd. Compton, CA 90220
11534	Duncan Electronics Inc. 2865 Fairview Road Costa Mesa, CA 92626
12406	Elpac Inc. 18651 Von Karman Avenue Irvine, CA 92664
16299	Corning Glass Works Electronic Components Division 3900 Electronics Drive Raleigh, NC 27604
16758	Delco Radio Division of General Motors Corp. Kokomo, IN
19701	Mepco/Electra Inc. Electra Division P.O. Box 760 Mineral Wells, TX 76067
23880	Sanford Applied Engineering Inc. 340 Martin Avenue Santa Clara, CA 95050
25088	Siemens Corp. 186 Wood Avenue S. Iselin, NJ 08830
27014	National Semiconductor Corp. 2950 San Ysidro Way Santa Clara, CA 95051
28520	Heyman Mfg. Co. 147 N. Michigan Avenue Kenilworth, NJ 07033
52542	Systron-Donner Corp. Instrument Division 2727 Systron Drive Concord, CA 94518
55210	Gettig Engineering & Mfg. P.O. Box 85 off Route 45 Spring Mill, PA 16875
56289	Sprague Electronic Co. North Adams, MA 01247
58474	Superior Electric Co. 383 Middle Street Bristol, CT 06010
70903	Belden Corp. 415 So. Kilpatrick Chicago, IL 60644
71002	Birnbach Co. Inc. 177 Hanse Avenue Freeport Long Island, NY 11520

REPLACEABLE PARTS LIST

TITLE: HHB SERIES SHIPPING ASSEMBLY #065251 Rev B

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-4	COVER, Top	52542	065189	065189	1
		1	ASSEMBLY, Front Panel	52542	06525201	06525201	1
		2	ASSEMBLY, Front Panel	52542	06525202	06525202	1
		3	ASSEMBLY, Front Panel	52542	06525203	06525203	1
		4	ASSEMBLY, Front Panel	52542	06525204	06525204	1
		1-4	PANEL, Front	52542	065658	065658	1
		1-4	SHIELD	52542	06542201	06542201	1
		1-4	COVER, Shield	52542	06542202	06542202	1
	M101	1	ASSEMBLY, Meter 5A	52542	06521001	06521001	1
	M101	2	ASSEMBLY, Meter 2A	52542	117468	117468	1
	M101	3	ASSEMBLY, Meter 1A	52542	06521201	06521201	1
	M101	4	ASSEMBLY, Meter 3A	52542	06521301	06521301	1
	M102	1	ASSEMBLY, Meter 7V	52542	06521401	06521401	1
	M102	2	ASSEMBLY, Meter 20V	52542	117467	117467	1
	M102	3	ASSEMBLY, Meter 50V	52542	06521601	06521601	1
	M102	4	ASSEMBLY, Meter 150V	52542	06521701	06521701	1
		1-4	HOLDER, Meter	52542	065191	065191	1
	R106	1	RESISTOR, Var 10k 5%, 2W	11534	3253	106149	1
	R105	2	RESISTOR, Var 20k 5%, 2W	52542	600374	600374	1
	R105	3	RESISTOR, Var 5 k 5%, 2W	80294	3540-1-503	102913	1
	R105	4	RESISTOR, Var 100 k 5%, 2W	52542	600455	600455	1
	R105	1	RESISTOR, MF 23.7 Ω 1%, 1/8W	81349	EE - 1/8	106339	1
	R101	1-4	RESISTOR, Var 100 Ω 10%, 2W	52542	600043	600043	1
		1-4	KNOB, Control	86797	R8-67-1-DC-M-L	100976	2
	1-4	1-4	SWITCH, AC ON/OFF		171-900-027	116654	1
	CR106	1-4	LED, Orange	50522	MV5153 W/Mtg Grm	103201	1
	J103	1-4	BINDING POST, Red	58474	DF 21 RC	102646	1
	J101	1-4	BINDING POST, Black	58474	DF 21 BC	102647	1
	J102	1-4	BINDING POST, White	58474	DF 21 WTC	102648	1
		1	LABEL, 0-6V, 5A	52542	781683	781683	1
		2	LABEL, 0-20V, 2A	52542	781684	781684	1
		3	LABEL, 0-50V, 1A	52542	781685	781685	1
		4	LABEL, 0-150V, .3A	52542	781686	781686	1
			ASSEMBLY, Rear Panel				
		1	ASSEMBLY, Rear Panel	52542	06565101	06565101	1
		2	ASSEMBLY, Rear Panel	52542	06565102	06565102	1
		3	ASSEMBLY, Rear Panel	52542	06565103	06565103	1
		4	ASSEMBLY, Rear Panel	52542	06565104	06565104	1
		1-4	FUSEHOLDER	75915	345001	117377	1
	F101	1-4	FUSE, SB 1A 3AG	75915	313001	100584	1
	TB101	1-4	STRIP, Barrier	52542	850096	850096	1
	P101	1-4	LINE CORD	70903	172378	102406	1
		1-4	BUSHING, Strain Relief	28520	SR-SP-4	103002	1
		1-4	BUSHING, Snap	28520	SB-250-2	100729	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

TITLE: HHB SERIES SHIPPING ASSEMBLY #065251 (Cont'd)

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-4	SPACER, Threaded 5/16	83330	8797	100827	1
		1-4	GUIDE, Card	23880	1450F	100855	1
		1-4	LINK, Shorting	52542	840217	840217	4
		1-4	PLATE, Insulator	52542	065295	065295	1
		1-4	COVER, Protective	52542	065362	065362	1
	C104	1	CAPACITOR, El Ax 4700 μF,16V	25088	4700/16/8200	117453	1
	C104	2	CAPACITOR, El Ax 1000 μF,40V	25088	1000/40/8200	117454	1
	C106	3	CAPACITOR, El Ax 500 μF,75V	52542	810223	810223	1
	C106	4	CAPACITOR, El Ax 75 μF,200V	52542	810116	810116	1
	R103	1	RESISTOR, WW 4Ω 5%, 50W	91637	RH50 4 5%	117455	1
	R103	2	RESISTOR, WW 20Ω 5%, 5W	91637	RH50 200 OHM 5%	117456	1
	R103	3	RESISTOR, WW 100Ω 5%, 50W	91637	RH50 100 OHM 5%	117457	1
	R103	4	RESISTOR, WW 900Ω 5%, 5W	91637	RH 50 900 OHM 5%1	117458	1
			CHASSIS ASSEMBLY				
		1	ASSEMBLY, Chassis	52542	06525302	06525302	1
		2	ASSEMBLY, Chassis	52542	06525304	06525304	1
		3	ASSEMBLY, Chassis	52542	06525306	06525306	1
		4	ASSEMBLY, Chassis	52542	06525307	06525307	1
		1-4	FEET, Rubber	52542	840192	840192	4
	T101	1	TRANSFORMER, Power	52542	504313	504313	1
	T101	2	TRANSFORMER, Power	52542	504323	504323	1
	T101	3	TRANSFORMER, Power	52542	504324	504324	1
	T101	4	TRANSFORMER, Power	52542	504325	504325	1
	C103	1	CAPACITOR, El Can 25000 μF,25V	99392	91S25JB253	820371	1
	C103	2	CAPACITOR, El Can 4800 μF,50V	19701	3110HB842U05C	117449	1
	C105	3	CAPACITOR, El Can 1700 μF,100V	19701	3110HB172U100	117450	1
	C105	4	CAPACITOR, El Can 350 μF,250V	19701	3110HB3517250	117451	1
		1	CLAMP, Capacitor	52542	900068	900068	1
		2-4	CLAMP, Capacitor	56289	CM5-22	100725	1
		1-4	PLATE, Mtg PCB	52542	065181	065181	1
		1-4	RETAINER, PCB	06915	ECHBS-51	117333	2
	CR101-3	1	DIODE, Rectifier 50V	04713	MR1120R	100424	3
	CR103	2	DIODE, Rectifier 50V	04713	MR1120R	100424	1
	CR105	3	DIODE, Rectifier 100V	04713	MR1121	720132	1
	CR105	4	DIODE, Rectifier 200V	02735	1N1202A	102884	1
	R102	1	RESISTOR, CC 470Ω 5%, 2W	01121	HB4715	101847	1
	R102	2	RESISTOR, CC 1.5k 5%, 2W	01121	HB1525	101741	1
	R102	3,4	RESISTOR, CC 4.7k 5%, 2W	01121	HB4725	106048	1
	R104	1	RESISTOR, CC 50Ω 5%, 2W	01121	HB5015	640295	1
	R104	2	RESISTOR, CC 300Ω 5%, 2W	01121	HB3015	640420	1
	R104	3,4	RESISTOR, CC 2Ω 5%, 2W	01121	HB2015	640530	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

TITLE			HHB SERIES SHIPPING ASSEMBLY #065251 (Cont'd)				
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1-4	TERMINAL	92825	3A1-A1	100481	2
		1-4	NAME PLATE, Serial & Model	52542	101040	101040	1
		1-4	LABEL, Warning	52542	065535	065535	1
			DIODE BOARD ASSEMBLY				
		2	ASSEMBLY, Diode Board	52542	06535501	06535501	1
		3,4	ASSEMBLY, Diode Board	52542	06535502	06535502	1
		2-4	BOARD, PC	52542	065353	065353	1
	CR101,02	2	DIODE, Rectangular 100V	05828	1N5401	710454	2
	CR101-04	3,4	DIODE, Rectangular 400V	04713	1N5395	100413	4
	C101,102	2	CAPACITOR, Cer .01 μF 20%,500V	91418	TYPE SM	10007501	2
	C101-04	3,4	CAPACITOR, Cer .01 μF 20%,500V	91418	TYPE SM	10007501	4
			HEATSINK ASSEMBLY				
		1-4	ASSEMBLY, Heatsink	52542	06525401	06525401	1
		1-4	HOLDER, Fuse	71400	HFA	116873	1
		1-4	CLIP	86928	4502-53-50-2C	116915	2
		1-4	SOCKET, Transistor	06776	MD-3452-G	830101	2
	Q101,102	1,2	TRANSISTOR, SINPN 40V	80103	PMD10K-40	117459	2
	Q101,102	3	TRANSISTOR, SINPN 80V	80103	PMD10K-80	117460	2
	Q101,102	4	TRANSISTOR, SINPN 300V	16758	DTS-411	700429	2
		1-4	HEATSINK	52542	065190	065190	1
	F102	1-4	FUSE, 1A 250V	75915	313001	100584	1
	R106,107	4	RESISTOR, CC 1k 5%, 1/2W	01121	EB1025	101467	2
	CR107,08	4	DIODE, Rectifier 50V	04713	1N5395	100413	2
	J104		CONNECTOR, PC 22-pin	05574	2VK22D/1-2	101168	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE			HHB SERIES TEST ASSEMBLIES #065251 Rev C				
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		2	ASSEMBLY, Test 6-5 OV	52542	06525101	06525101	1
		2	ASSEMBLY, Test 20-2 OV	52542	06525103	06525103	1
		3	ASSEMBLY, Test 50-1 OV	52542	06525105	06525105	1
		4	ASSEMBLY, Test 150-.3 OV	52542	06525107	06525107	1
1		1	ASSEMBLY, Chassis	52542	06525301	06525301	1
1		2	ASSEMBLY, Chassis	52542	06525303	06525303	1
1		3	ASSEMBLY, Chassis	52542	06525305	06525305	1
1		4	ASSEMBLY, Chassis	52542	06525307	06525307	1
2		1	ASSEMBLY, Panel	52542	06525201	06525201	1
2		2	ASSEMBLY, Panel	52542	06525202	06525202	1
2		3	ASSEMBLY, Panel	52542	06525203	06525203	1
2		4	ASSEMBLY, Panel	52542	06525204	06525204	1
3		1	ASSEMBLY, Control PC	52542	06515801	06515801	1
3		2	ASSEMBLY, Control PC	52542	06515803	06515803	1
3		3	ASSEMBLY, Control PC	52542	06515805	06515805	1
3		4	ASSEMBLY, Control PC	52542	06515807	06515807	1
4		1-4	SCREW, PHMS 6-32 x 3/8	96906	MS51957-28	10063206	2
5		1-4	WASHER, Split-Lock #6	96906	MS35338-136	100712	2
6		1-4	LABEL, Warning	52542	065535	065535	1
7		1	ASSEMBLY, Rear Panel	52542	06565101	06565101	1
7		2	ASSEMBLY, Rear Panel	52542	06565102	06565102	1
7		3	ASSEMBLY, Rear Panel	52542	06565103	06565103	1
7		4	ASSEMBLY, Rear Panel	52542	06565104	06565104	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE			HHB SERIES CHASSIS ASSEMBLY #065253 Rev B				
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		1-4	CHASSIS	52542	065652	065652	1
2		1-4	ASSEMBLY, Heatsink	52542	06525401	06525401	1
3	T101	1	TRANSFORMER	52542	054313	054213	1
3	T101	2	TRANSFORMER	52542	504323	504323	1
3	T101	3	TRANSFORMER	52542	504324	504324	1
3	T101	4	TRANSFORMER	52542	504325	504325	1
4		1	CAPACITOR, El Can 25000 μF,25V	99392	91S25JB253	820371	1
4	C103	2	CAPACITOR, El Can 4800 μF,50V	19701	311HB842U05C	117449	1
4	C105	3	CAPACITOR, El Can 1700 μF,100V	19701	3110HB172U100	117450	1
4	C105	4	CAPACITOR, El Can 350 μF,250V	19701	3110HB3517250	117451	1
5		1	CLAMP, Capacitor	52542	900068	900068	1
5		2-4	CLAMP, Capacitor	52542	CM5-22	100725	1
6		1-4	PLATE, Mtg. PCB	52542	065181	065181	1
7		1-4	LUG, Solder #10			960130	2
8		1-4	JUMPER	55210	L-2007-1	102879	2
9		1-4	ASSEMBLY, Wiring Harness	52542	065255	065255	1
10		1-4	FEET, Rubber	52542	840192	840192	4
13		1-4	SCREW, FHMS 6-32 x 5/16	96906	MS24693-C25	10073105	1
14		1-4	SCREW, PHMS 6-32 x 3/8	96906	MS51957-28	10063206	3
15		1-4	SCREW, PHMS 6-32 x 9/16	08547	By Description	100851	5
17		1,4	NUT, Hex 6-32	96906	MS35649-264	100706	5
17		2,3	NUT, Hex 6-32	96906	MS35649-264	100706	7
18		1,4	WASHER, Flat #6	96906	MS15795-805	100704	9
18		2,3	WASHER, Flat #6	96906	MS15795-805	100704	11
19		1,4	WASHER, Split-Lock #6	96906	MS35338-136	100712	10
19		2,3	WASHER, Split-Lock #	96906	MS35338-136	100712	12
20		1-4	SCREW, PHMS 4-40 x 1/4	96906	MS51957-13	10062604	2
21		1-4	SCREW, PHMS 4-40 x 3/8	96906	MS51957-15	10062606	2
22		1-4	WASHER, Flat #4	96906	MS15795-906	100703	2
23		1-4	WASHER, Split-Lock #4	96906	MS35338-135	100711	4
24		1-4	SCREW, PHMS 8-32 x 3/8	96906	MS51957-43	10064206	5
25		1-4	NUT, Hex 8-32	96906	NAS671C8	100708	5
26		1-4	WASHER, Flat #8	96906	MS15795-807	100705	4
27		1-4	WASHER, Internal Tooth #8	96906	MS35333-72	100687	1
28		1-4	WASHER, Split-Lock #8	96906	MS35338-137	100713	4
29		1-4	TERMINAL	92825	3A1-A1	100481	2
30	R102	1	RESISTOR, CC 470 Ω 5%, 2W	01121	HB4715	101847	1
30	R102	2	RESISTOR, CC 1.5 k 5%, 2W	01121	HB1525	101741	1
30	R102	3	RESISTOR, CC 4.7 k 5%, 2W	01121	HB4725	106048	1
30	R102	4	RESISTOR, CC 47 k 5%, 2W	01121	HB4735	101654	1
31	R104	1	RESISTOR, CC 50 Ω 5%, 5W			640295	1
31	R104	2	RESISTOR, CC 300 Ω 5%, 5W			640420	1
31	R104	3	RESISTOR, CC 2 k 5%, 5W			640530	1
31	R104	4	RESISTOR, CC 12 k 5%, 5W			640572	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE	HHB SERIES CHASSIS ASSEMBLY #065253 (Cont'd)						
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
32	CR101-03	1	DIODE, Rectifier 50V	04713	MR1120R	100424	3
32	CR103	2	DIODE, Rectifier 50V	04713	MR1120R	100424	1
32	CR105	3	DIODE, Rectifier 9.4V	04713	1N1200A	720132	1
32	CR105	4	DIODE, Rectifier 200V	02735	1N1202A	102884	1
33		1	LUG, Diode			Supplied	3
33		2-4	LUG, Diode			Supplied	1
34		1	WASHER, Diode Mica			990397	6
34		2-4	WASHER, Diode Mica			990307	2
35		1	RING, Insulator			990350	3
35		2-4	RING, Insulator			990350	1
36		1	WASHER, Int-Tooth #10	96906	MS35333-73	100698	3
36		2-4	WASHER, Int-Tooth #10	96906	MS35333-73	100698	1
37		1	NUT, Hex			Supplied	3
37		2-4	NUT, Hex			Supplied	1
38		1	WASHER, Flat #10	96906	MS15795-808	100648	3
38		2-4	WASHER, Flat #10	96906	MS15795-808	100648	1
39	CR205	1-3	DIODE, SCR 100V (OV Option)	03508	C231A	117341	1
40		1-3	LUG, Diode			960640	1
41		1-3	WASHER, Mica			990295	2
42		1-3	RING, Insulator			990340	1
43		1-3	WASHER, Flat			990040	1
44		1-3	WASHER, Lock Int-Tooth			990181	1
45		1-3	NUT, Hex			980128	1
46	C105	1,2	CAPACITOR, Cer .01 μF 5%,500V	91418	TYPE SM	10007501	1
46	C107	3	CAPACITOR, Cer. .01 μF 5%,100V	91418	TA110	100103	1
47		1-4	ASSEMBLY, Front Panel	52542	065193	065193	1
48		1-4	ASSEMBLY, Rear Panel	52542	065651	065651	1
49		1-4	LUG, Solder #6	83330	1413-6	100486	1
50		1-4	ASSEMBLY, Retainer PCB	52542	117333	117333	2
51	C101,02	1	CAPACITOR, Cer .01 μF 5%, 500V	91418	TYPE SM	10007501	2
51		2-4	WASHER, Fiber	83330	2163	100974	4
52		1	NAME PLATE	52542	101040	101040	1
52		2-4	ASSEMBLY, Diode	52542	06535502	06535502	1
53		2-4	NAMEPLATE	52542	101040	101040	1

Used On Code: 1 = HHB6-5 2 = HHB20-3 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE: HHB SERIES HEAT SINK ASSEMBLY

ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		1-4	HEAT SINK	52542	065190	065190	1
2	Q101,02	1,2	TRANSISTOR, SINPN 40V	80103	PMD10K-40	117459	2
2	Q101,02	3	TRANSISTOR, SINPN 80V	80103	PMD10K-80	117460	2
2	Q101,02	4	TRANSISTOR, SINPN 300V	16758	DTS411	700429	2
3	XQ101,02	1-4	SOCKET, Transistor	52542	830101	830101	2
4		1-4	INSULATOR, Mica	52542	T990280	T990280	2
5		1-4	SCREW, PHMS 6 x 5/8	52542	T970900	T970900	4
6	R106	4	RESISTOR, CC 1 k 5%, 1/2W	01121	CB1025	101569	2
7	R107	4	Same as R106				
8	CR107	4	DIODE, Rectifier 400V	04713	1N5395	100413	2
9	CR108	4	Same as CR107				

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE			HHB SERIES PANEL ASSEMBLY				
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
1		1-4	PANEL	52542	065193	065193	1
2	M101	1	ASSEMBLY, Amp Meter 0-5A	52542	06521001	06521001	1
2	M101	2	ASSEMBLY, Amp Meter 0-2A	52542	117468	117468	1
2	M101	3	ASSEMBLY, Amp Meter 0-1A	52542	06521201	06521201	1
2	M101	4	ASSEMBLY, Amp Meter 0-.3A	52542	06521301	06521301	1
3	M102	1	ASSEMBLY, Volt Meter 0-7A	52542	06521401	06521401	1
3	M102	2	ASSEMBLY, Volt Meter 0-20V	52542	117467	117467	1
3	M102	3	ASSEMBLY, Volt Meter 0-50V	52542	06521601	06521601	1
3	M102	4	ASSEMBLY, Volt Meter 0-150V	52542	06521701	06521701	1
4		1-4	HOLDER, Meter	52542	065191	065191	1
5		1-4	SCREW, PHMS 4-40 x 3/4	52542	970041	970041	2
6		1-4	ASSEMBLY, I LED	52542	MV5253 W/Mtg Grm	103201	1
7		1-4	KNOB (P/O R101, R106)	86797	RB-67-1-DC-M-L	100976	2
8	R101	1-4	RESISTOR, Var 100 Ω 10%, 2W	81349	RA20NASD101A	600043	1
9		1-4	JUMPER	71002	1423	112605	1
10	R105	2	RESISTOR, Var 20 k 5%, 2W	52542	600374	600374	1
10	R105	3	RESISTOR, Var 50 k 5%, 2W	80294	3540-1-503	102913	1
10	R105	4	RESISTOR, Var 100 k 5%, 2W	52542	600455	600455	1
10	R106	1	RESISTOR, Var 10 k 5%, 2W	11534	3253	106149	1
11		1-4	JUMPER	55210	L-2007-1	102879	1
12	S101	1-4	SWITCH, DPST AC	52542	116654	116654	1
13		1-4	BINDING POST, Black	58474	DF21BC	102647	1
14		1-4	BINDING POST, White	58474	DF21WTC	102648	1
15		1-4	BINDING POST, Red	58474	DF21RC	102646	1
16		1	NAMEPLATE, 0-6V, 5A	52542	781683	781683	1
16		2	NAMEPLATE, 0-20V, -2A	52542	781684	781684	1
16		3	NAMEPLATE, 0-50V, 1A	52542	781685	781685	1
16		4	NAMEPLATE, 0-150V, .3A	52542	781686	781686	1
17		1-4	TAPE, Foam 1/2 x 1/16	52542	74041390	74041390	A/R
18		1-4	SHIELD, Var	52542	06542201	06542201	1
19		1-4	COVER, Shield	52542	06542202	06542202	1
21		1-4	WASHER, Lock Int Tooth	52542	990190	990190	2
20		1-4	WASHER, Flat	52542	990043	990043	1
22		1-4	NUT, Hex			Supplied	2
23		1-4	Grommet	52542	910010	910010	1
24		1	RESISTOR, MF 23.7 k 1%, 1/8W		EE-1/8	106339	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE	HHB SERIES CONTROL PC ASSEMBLY						
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		1	ASSEMBLY, Control PC	52542	06515802	06515802	Ref
		2	ASSEMBLY, Control PC	52542	06515804	06515804	Ref
		3	ASSEMBLY, Control PC	52542	06515806	06515806	Ref
		4	ASSEMBLY, Control PC	52542	06515807	06515807	Ref
		1-4	BOARD, PC	52542	065148	065148	1
	C1	1-4	CAPACITOR, Ceramic .01 µF 5%, 100V	91418	TA110	100103	3
	C2	1-4	Same as C1				
	C3	1-4	CAPACITOR, El Ax 470 µF, 40V	99392	ET471X040A02	103383	1
	C4	1-4	CAPACITOR, DM 330 pF 5%, 500V	72136	DM15FD331JO	10027601	1
	C5	1-4	CAPACITOR, Tant 15 µF 10%, 20V	56289	150D156X9020B2	100211	3
	C6	Same	Same as C5				
	C7	1-4	CAPACITOR, DM 33 pF 5%, 500V	72136	DM15ED330JO	10017501	1
	C8	1-4	CAPACITOR, DM 68 pF 5%, 500V	72136	DM15ED680JO	100239	1
	C9	1,2	CAPACITOR, Tant 1 µF 10%, 35V	56289	150D105X9035A2	100082	1
	C9	3,4	CAPACITOR, Met Mylar .47 µF 20%, 200V	12406	ZD2A474	102584	1
	C10	1-4	CAPACITOR, Tant 56 µ 10%, 6V	56289	150D566X9006B2	100225	2
	C11	1-4	Selected in Test				
	C12	1-4	CAPACITOR, DM 150 pF 5%, 500V	72136	DM15FD151JO	100219	1
	C13	1-4	Selected in Test				
	C14	1-4	Same as C1				
	C15	1-4	Same as C10				
	C16	1-4	Same as C5				
	C201	1-3	CAPACITOR, Tant 2.2 µF 10%, 35V	56289	150D225X9035B2	100100	1
	C202	1-3	CAPACITOR, Ceramic .005 µF 20%, 500V	91418	SM250	100077	1
	CR1	1-4	DIODE, Rectifier 400V	04713	1N5395	100413	6
	CR2	1-4	Same as CR1				
	CR3	1-4	DIODE, Zener 5.6V	03877	1N752A	100376	1
	CR4	1-4	DIODE, Reference 9V	04713	1N936	106551	1
	CR5	1-4	Not Used				

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

TITLE			HHB SERIES CONTROL PC ASSEMBLY (Cont'd)				
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	CR6	4	DIODE, Signal 50V	03508	1N4151	100385	11
	CR7 thru CR9	1-3	DIODE, Signal 50V	03508	1N4151	100385	8
	CR9 thru CR12	4	Same as CR6				
	CR10	1-3	Not Used				
	CR11	1-3	Not Used				
	CR12	1-4	Same as CR1				
	CR13	1-3	Same as CR7				
	CR13	4	Same as CR6				
	CR14	1-3	Same as CR7				
	CR14	4	Same as CR6				
	CR15	1-4	Same as CR1				
	CR16	1-3	Same as CR7				
	CR16	4	Same as CR6				
	CR17	1-4	Same as CR1				
	CR18	1-4	DIODE, Reference 6.2V	04713	1N823	720461	1
	CR19	1-3	Same as CR7				
	CR19	4	Same as CR6				
	CR20	1-4	Same as CR1				
	CR21	1-4	DIODE, Zener 6.8V	04713	1N957B	100416	1
	CR201	1-3	DIODE, Zener 24V	04713	1N4749A	720155	1
	CR202	1-3	Same as CR6				
	CR203	1-3	Same as CR6				
	CR204	1-3	Same as CR21				
	Q1	1-4	TRANSISTOR, JFET N-Channel	04713	2N4340	705069	1
	Q2	1-4	TRANSISTOR, SINPN 30V	07263	PN3643-5	101358	1
	Q3	1-4	TRANSISTOR, SIPNP 40V	04713	2N3906	101378	1
	Q201	3	TRANSISTOR, SINPN 40V	04713	2N3904	101377	1
	Q202	3	TRANSISTOR, SINPN 160V	07263	2N5831	102676	1
	Q203	1-3	TRANSISTOR, Thyristor 8V	04713	2N4990	741001	1
	R1	1-4	RESISTOR, MF 13.7 k 1%, 1/8W	19701	MF5C-D-1372-F	102172	1
	R2	1-4	RESISTOR, MF 100 k 1%, 1/8W	91637	MFF 1/8 T1	102080	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE	HHB SERIES CONTROL PC ASSEMBLY (Cont'd)						
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R3	1-4	RESISTOR, MF 10 k 1%, 1/8W	19701	MF5C-D-1002-F	102098	1
	R4	1-4	RESISTOR, MF 150 Ω 1%, 1/8W	81349	RN60D1500F	106220	1
	R5	1-4	RESISTOR, Variable 1 k 10%, 3/8W	73138	89PR1K	102181	1
	R6	1-3	RESISTOR, MF 8.4 k 1%, 1/2W	81349	RN65D8451F	620598	1
	R6	4	RESISTOR, MF 5.62 k 1%, 1/4W	01121	RN6505621F	620582	1
	R7	1-4	RESISTOR, CC 33 k 5%, 1/4W	01121	CB3335	101576	1
	R8	1-4	Not Used				
	R9	1-4	RESISTOR, CC 10 M 5%, 1/4W	01121	CB1065	101564	1
	R10	1-4	RESISTOR, CC 2.4 M 5%, 1/4W	01121	CB2455	106002	1
	R11	1-3	RESISTOR, Variable 5 k 10%, 1/2W	73138	72PR5K	103788	1
	R11	4	RESISTOR, Variable 5 k 10%, 1/2W	73138	72PR5K	103788	2
	R12	4	RESISTOR, CC 270 k 5%, 1/4W	01121	CB2745	101769	1
	R13	1	RESISTOR, CC 8.2 k 5%, 1/4W	01121	CB8225	101595	1
	R13	2	RESISTOR, CC 9.1 k 5%, 1/4W	01121	CB9125	101573	1
	R13	3	RESISTOR, CC 10 k 5%, 1/4W	01121	CB1035	101570	1
	R13	4	RESISTOR, CC 12 k 5%, 1/4W	01121	CB1235	101565	1
	R14	1-4	RESISTOR, CC 100 Ω 5%, 1/4W	01121	CB1015	101609	1
	R15	1-4	RESISTOR, CC 5.1 k 5%, 1/4W	01121	CB5125	101541	1
	R16	1-4	RESISTOR, CC 4.7 k 5%, 1/4W	01121	CB4725	101598	1
	R17	1	RESISTOR, Variable 1 k 10%, 1/2W	73138	72PR1K	103787	1
	R17	2,3	Same as R11				
	R17	4	RESISTOR, Variable 50 k 20%, 1/2W	73138	91B50K	106110	2

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

TITLE	HHB SERIES CONTROL PC ASSEMBLY (Cont'd)						
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R18	1	RESISTOR, MF 6.65 k 1%, 1/8W	19701	MF5C-D-6651F	102094	1
	R18	2	RESISTOR, MF 18.2 k 1%, 1/8W	19701	MF5C-D-1822F	102139	1
	R18	3	RESISTOR, MF 47.5 k 1%, 1/8W	81349	RN60C4752F	106189	1
	R18	4	RESISTOR, MF 121 k 1%, 1/8W	16299	NA60	106216	1
	R19	1-4	RESISTOR, CC 820 Ω 5%, 1/4W	01121	CB8215	101567	1
	R20	1-4	RESISTOR, CC 22 k 5%, 1/4W	01121	CB2235	101572	1
	R21	1-4	Selected in Test				
	R22	1	RESISTOR, WW .02 Ω 3%, 5W	52542	117463	117463	1
	R22	2	RESISTOR, WW .05 Ω 3%, 5W	52542	117464	117464	1
	R22	3	RESISTOR, WW .1 Ω 3%, 5W	52542	117465	117465	1
	R22	4	RESISTOR, WW .33 Ω 3%, 5W	52542	117466	117466	1
	R23	1-4	RESISTOR. Variable 100 Ω 10%, 1/2W	73138	72PR100	117188	1
	R24	1-4	RESISTOR, Variable 2 k 10%, 5W	73138	72PR2K	117826	1
	R25	1-4	RESISTOR, MF 4.99 k 1%, 1/8W	91637	MFF 1/8 T1	102079	1
	R26	4	RESISTOR, CC 15 k 5%, 1/4W	01121	CB1535	101552	2
	R201	4	RESISTOR, CC 100 k 5%, 1/4W	01121	CB1045	101558	1
	R202	1	RESISTOR, MF 2.67 k 1%, 1/8W	91637	MFF 1/8 T1	106232	1
	R202	2	RESISTOR, MF 7.50 k 1%, 1/8W	91637	MFF 1/8 T1	102278	1
	R202	3	RESISTOR, MF 6.65 k 1%, 1/8W	19701	MF5C-D-2003-F	102094	1
	R203	2	RESISTOR, Variable 2 k 10%, 3/8W	73138	89PR2K	102119	1
	R203	2,3	RESISTOR, Variable 10 k 10%, 3/8W	73138	89PR10K	102472	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

REPLACEABLE PARTS LIST

TITLE	HHB SERIES CONTROL PC ASSEMBLY (Cont'd)						
ITEM	REF	USED ON	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R204	1	RESISTOR, MF 2.21 k 1%, 1/8W	16299	NA60	106226	1
	R204	2	RESISTOR, MF 2 k 1%, 1/8W	16299	NA60	106224	1
	R204	3	RESISTOR, MF 750 Ω 1%, 1/8W	16299	NA60	102252	1
	R205	3	RESISTOR, CC 47 Ω 5%, 1/4W	01121	CB4705	101560	2
	R206	1,2	RESISTOR, CC 1 k 5%, 1/4W	01121	CB1025	101569	2
	R207	1	RESISTOR, CC 27 Ω 5%, 1/4W	01121	CB2705	101729	1
	R207	2	RESISTOR, CC 47 Ω 5%, 1/4W	01121	CB4705	101560	2
	R207	3	Same as R205				
	R208	3	RESISTOR, CC 470 Ω 5%, 1/4W	01121	CB4715	101625	1
	R209	1-3	RESISTOR, CC 4.7 k 5%, 1/4W	01121	CB4725	101598	1
	R210	1,3	RESISTOR, CC 1 k 5%, 1/4W	01121	CB1025	101569	1
	R210	2	Same as R206				
	R211	3	RESISTOR, CC 2.2 k 5%, 1/2W	01121	EB2225	101454	1
	R212	1	RESISTOR, CC 47 Ω 5%, 1/4W	01121	CB4705	101560	1
	R212	2	Same as R207				
	U1 thru U3	1-4	INTEGRATED CIRCUIT Operational Amplifier	27014	LM301AH	025745	3
	U201	1-3	INTEGRATED CIRCUIT , LIN MSC SCR Driver	04713	MC3423	117469	1

Used On Code: 1 = HHB6-5 2 = HHB20-2 3 = HHB50-1 4 = HHB150-.3

CHAPTER 6

DRAWINGS

6.1 INTRODUCTION

This chapter contains the assembly and schematic drawings for the HHB Quarter Rack Series Power Supplies. The schematic diagrams relate to the circuit details described throughout this manual. The parts list contained in Chapter 5 relate to the reference designation and item callouts on the diagrams.

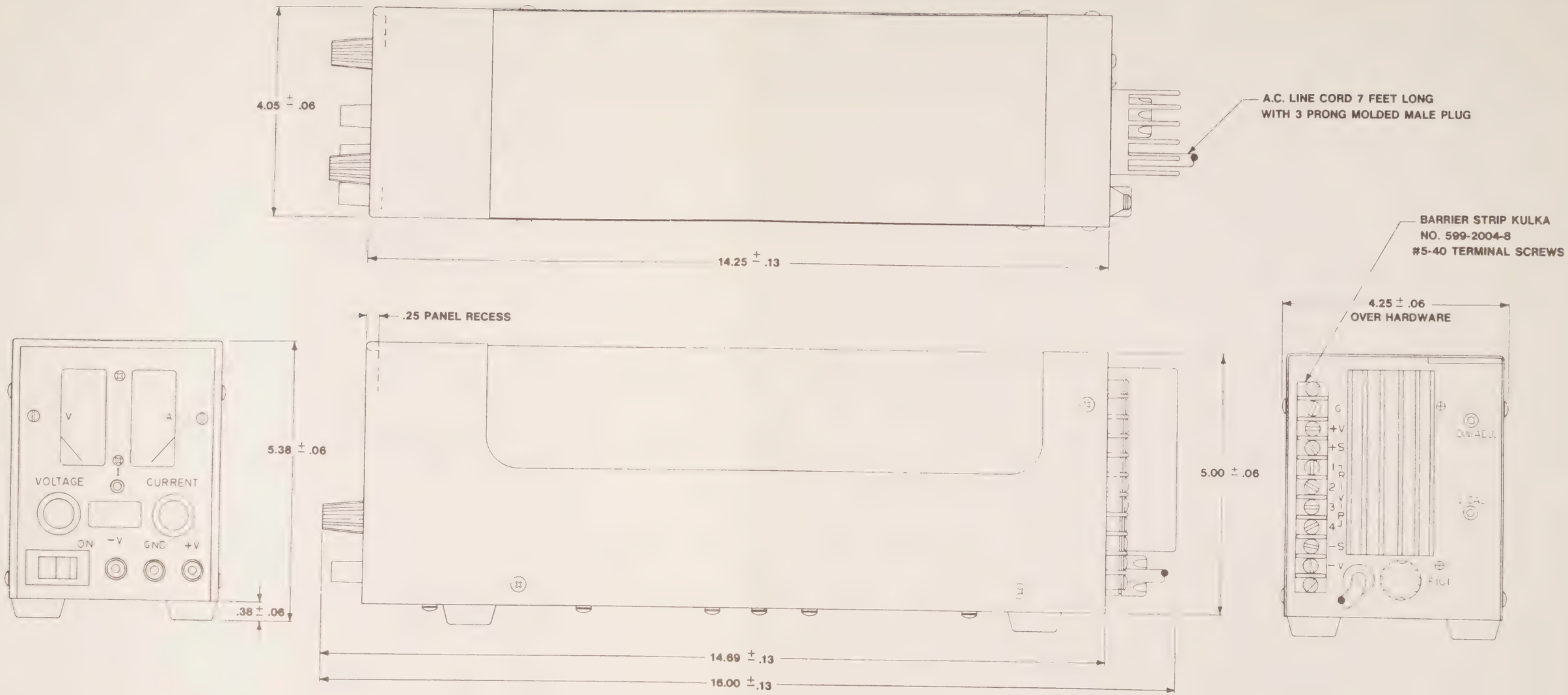


FIGURE 6-1
HHB SERIES DIMENSIONAL OUTLINE
#065253

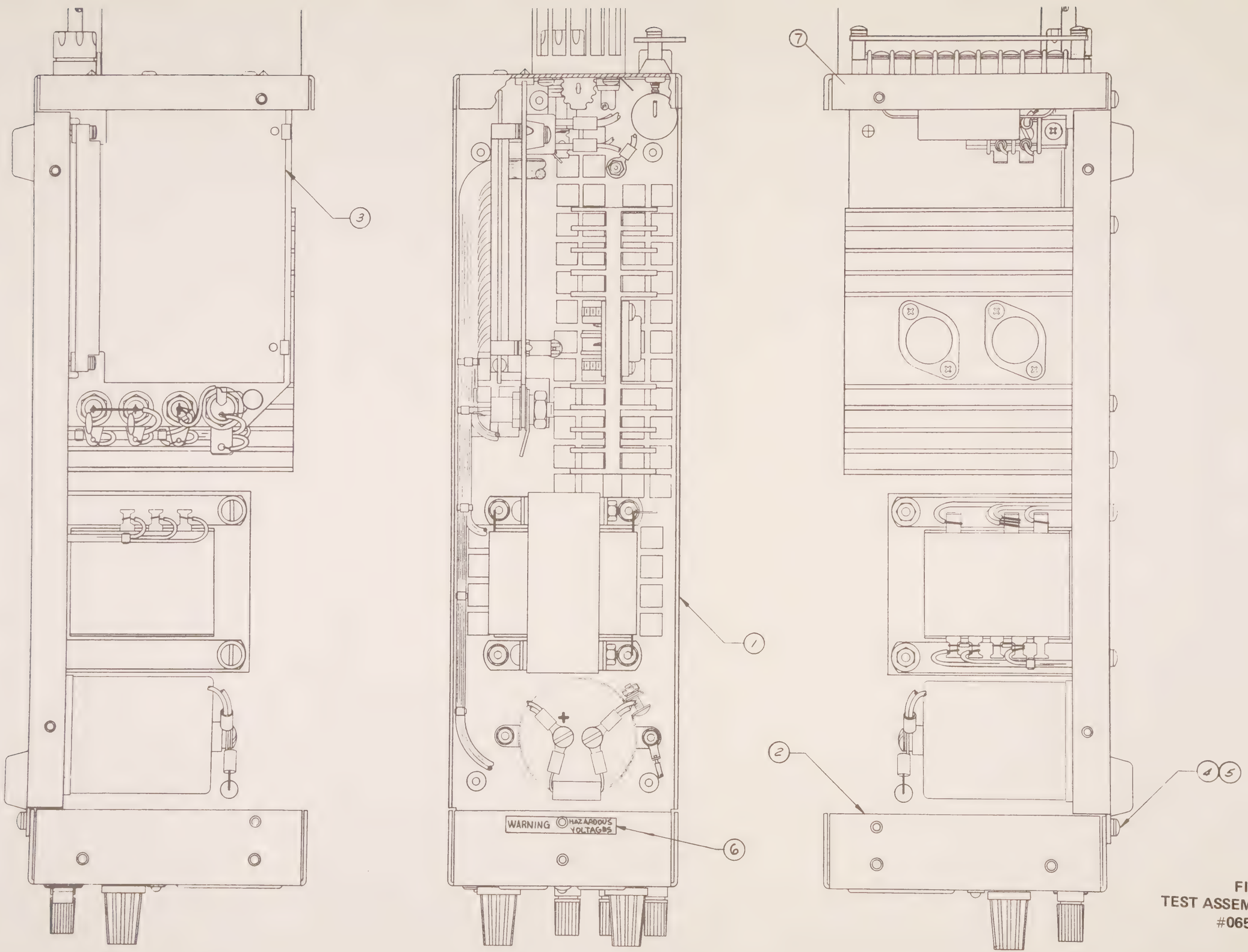
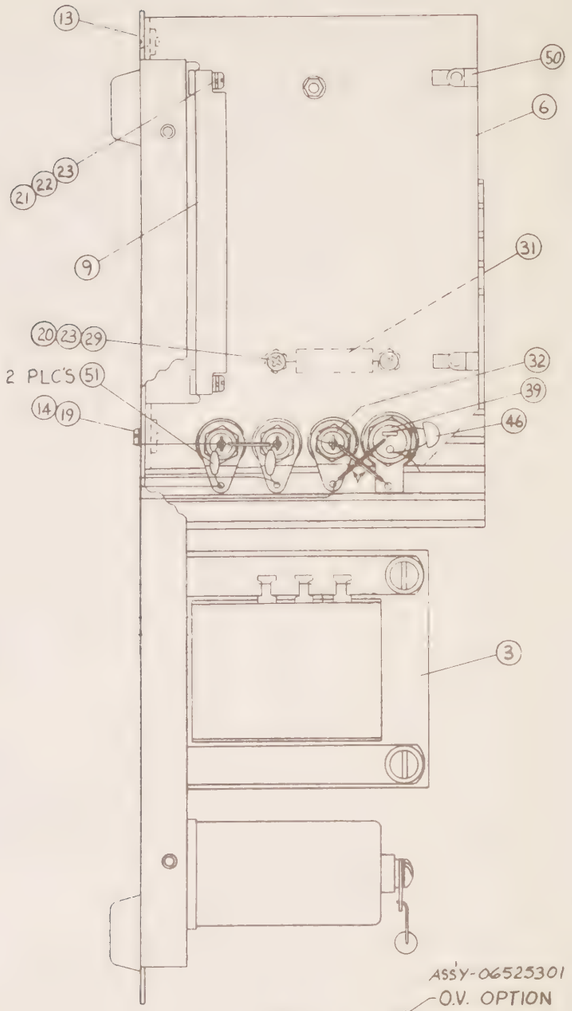
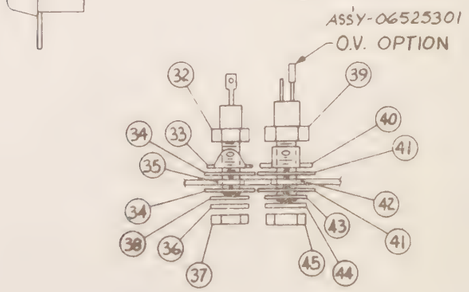
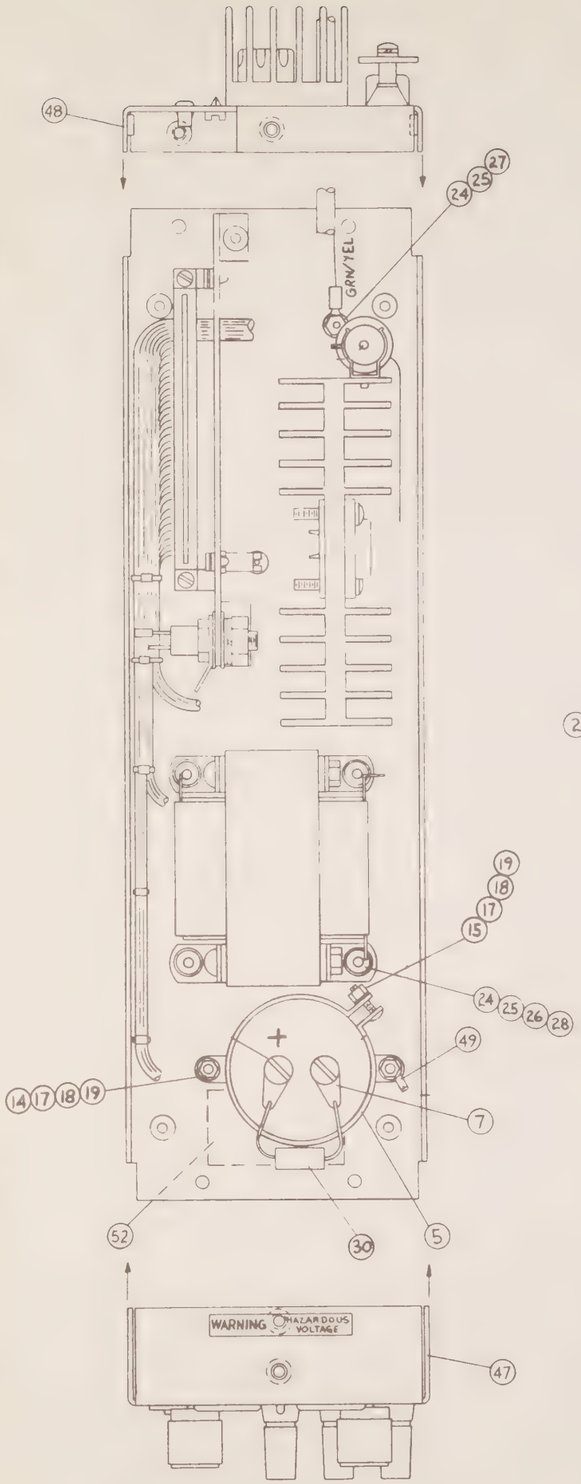


FIGURE 6-2
TEST ASSEMBLY HHB SERIES
#065251 Rev C

XFORMER CONNECTIONS			
VOLTAGE	FROM	TO	JUMPERS
100	S101-1	T101-4	1-3, 2-5
115/120		T101-5	1-3, 2-5
208/220		T101-4	2-3
230/240	S101-1	T101-5	2-3







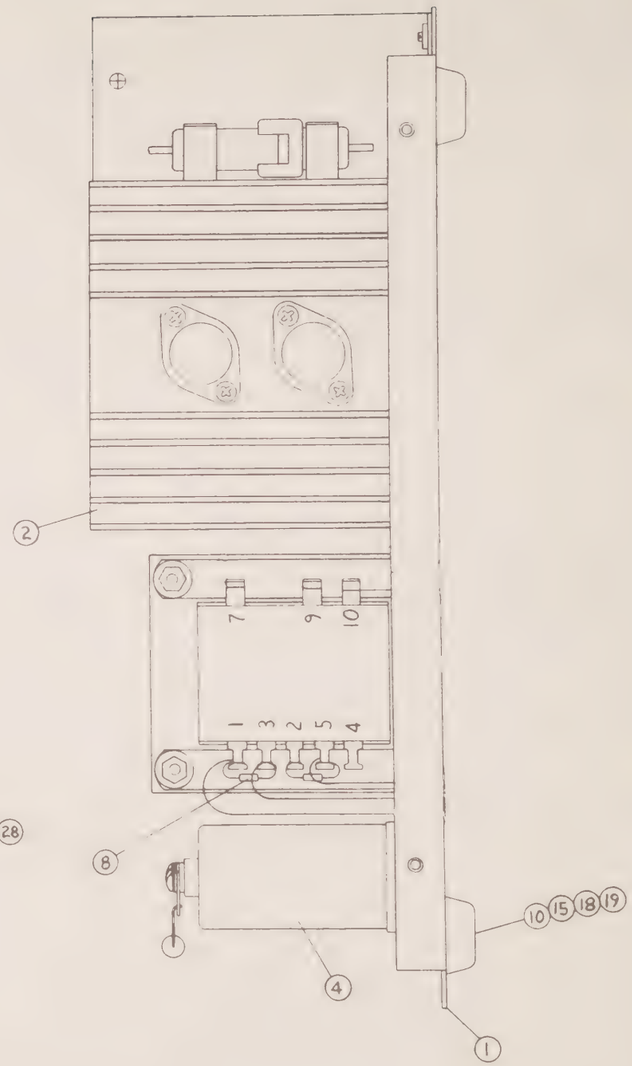


FIGURE 6-3
MODEL HHB 6-5 CHASSIS ASSEMBLY
#06525302 Rev B

XFORMER CONNECTIONS			
VOLTAGE	FROM	TO	JUMPERS
100	S101-1	T101-4	1-3, 2-5
115/120		T101-5	1-3, 2-5
208/220		T101-4	2-3
230/240	S101-1	T101-5	2-3

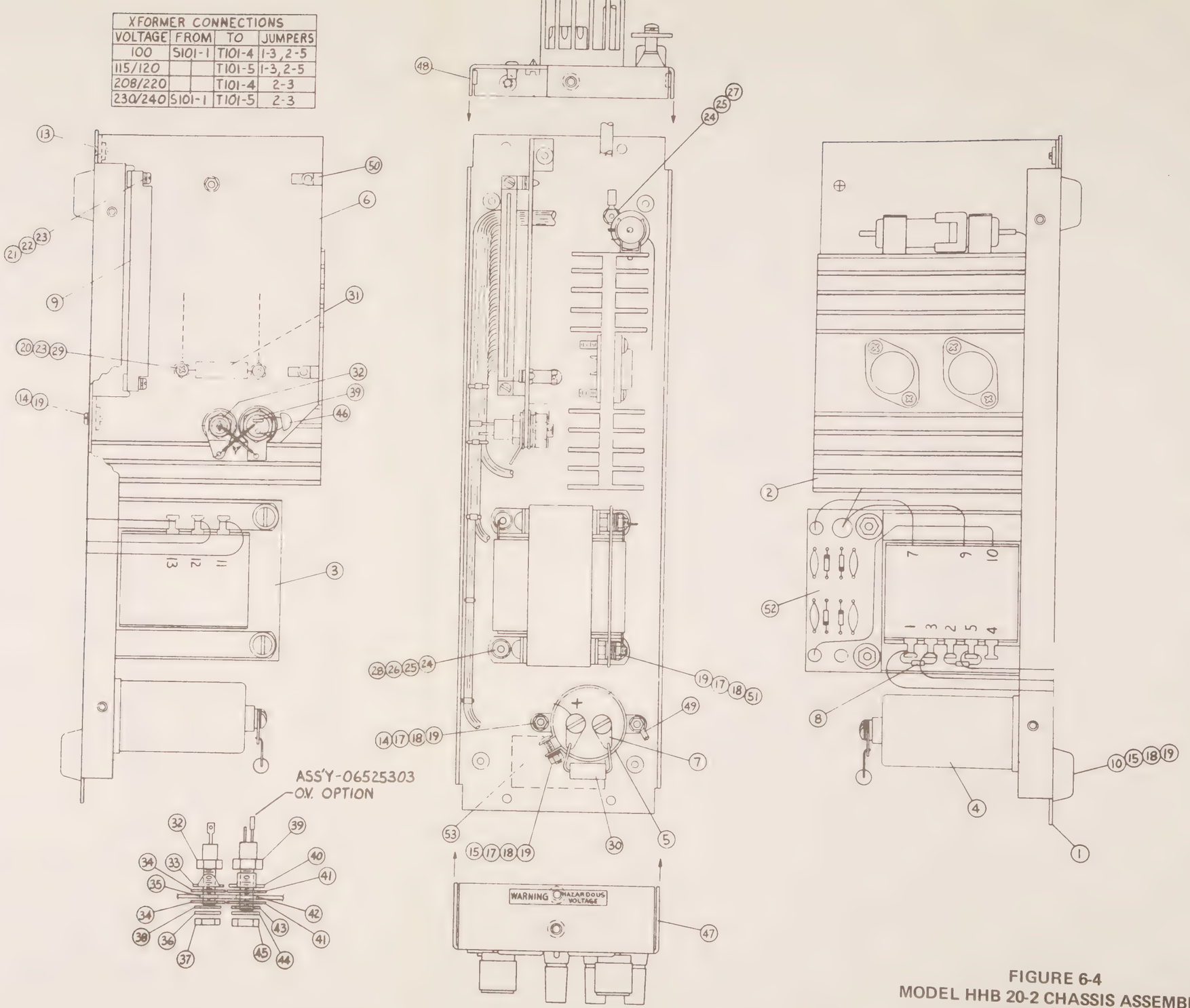


FIGURE 6-4
MODEL HHB 20-2 CHASSIS ASSEMBLY
#06525304 Rev B

XFORMER CONNECTIONS			
VOLTAGE	FROM	TO	JUMPERS
100	S101-1	T101-4	1-3, 2-5
115/120		T101-5	1-3, 2-5
208/220		T101-4	2-3
230/240	S101-1	T101-5	2-3

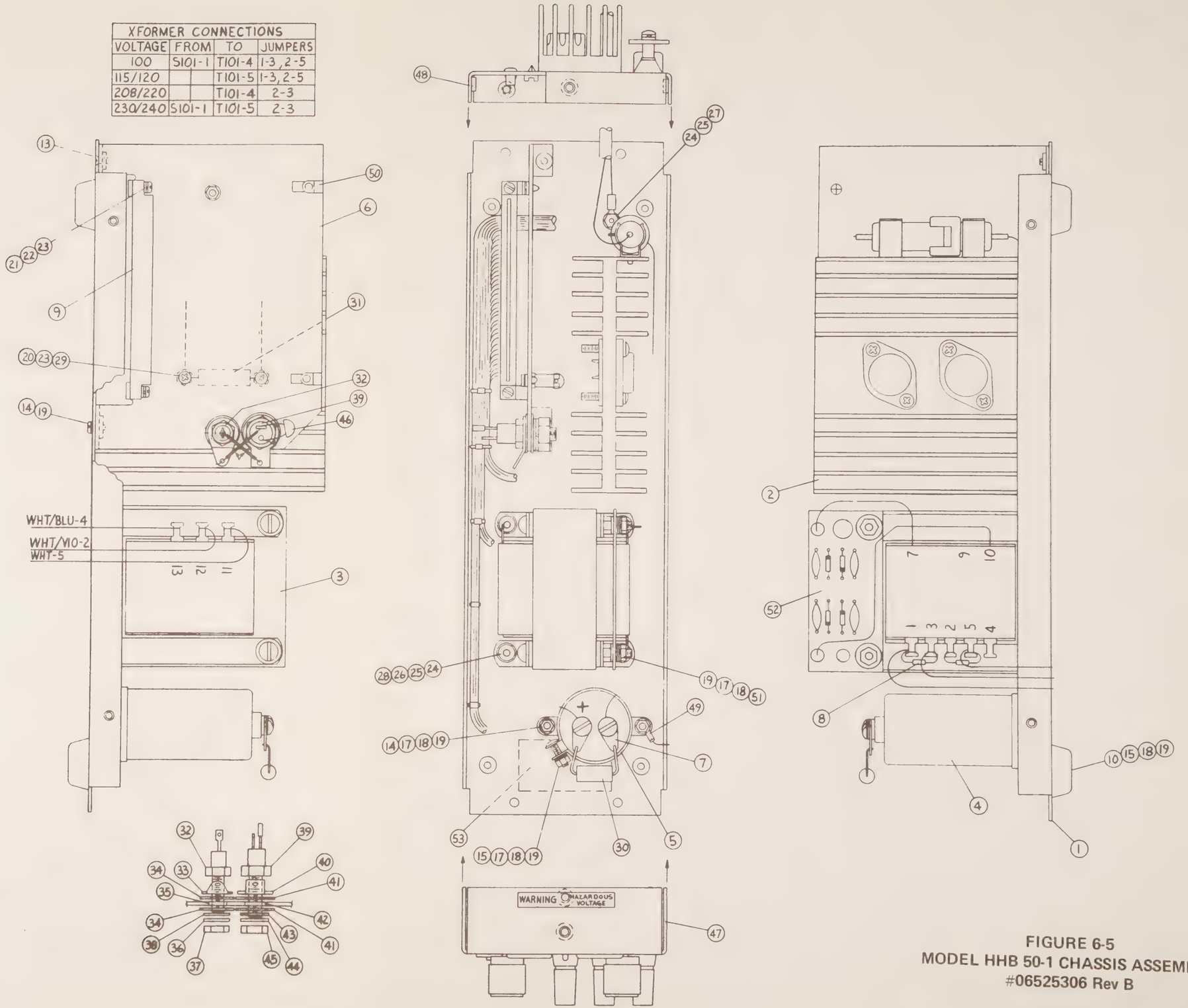


FIGURE 6-5
MODEL HHB 50-1 CHASSIS ASSEMBLY
#06525306 Rev B

XFORMER CONNECTIONS			
VOLTAGE	FROM	TO	JUMPERS
100	S101-1	T101-4	1-3, 2-5
115/120		T101-5	1-3, 2-5
208/220		T101-4	2-3
230/240	S101-1	T101-5	2-3

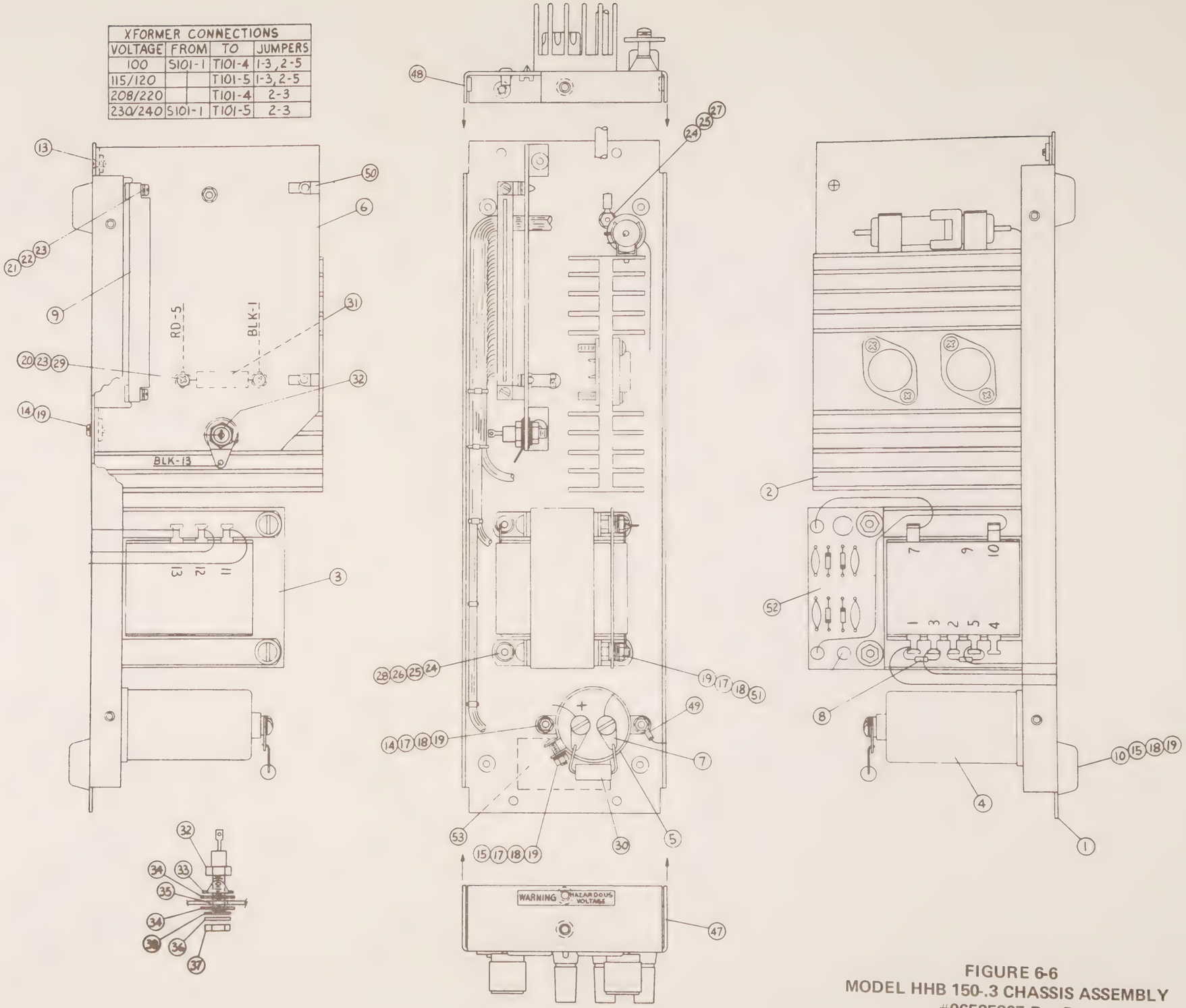


FIGURE 6-6
MODEL HHB 150-.3 CHASSIS ASSEMBLY
#06525307 Rev B

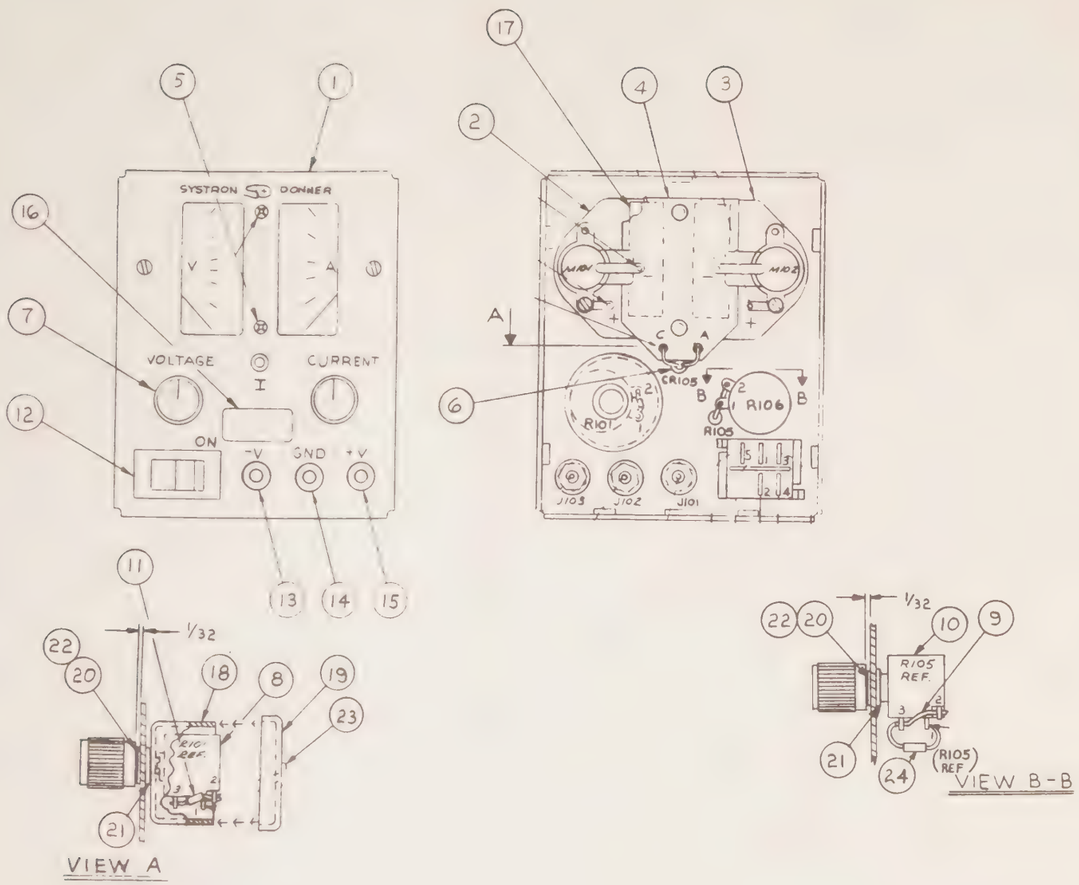


FIGURE 6-7
MODEL HHB 6-5 PANEL ASSEMBLY
#06525201 Rev C

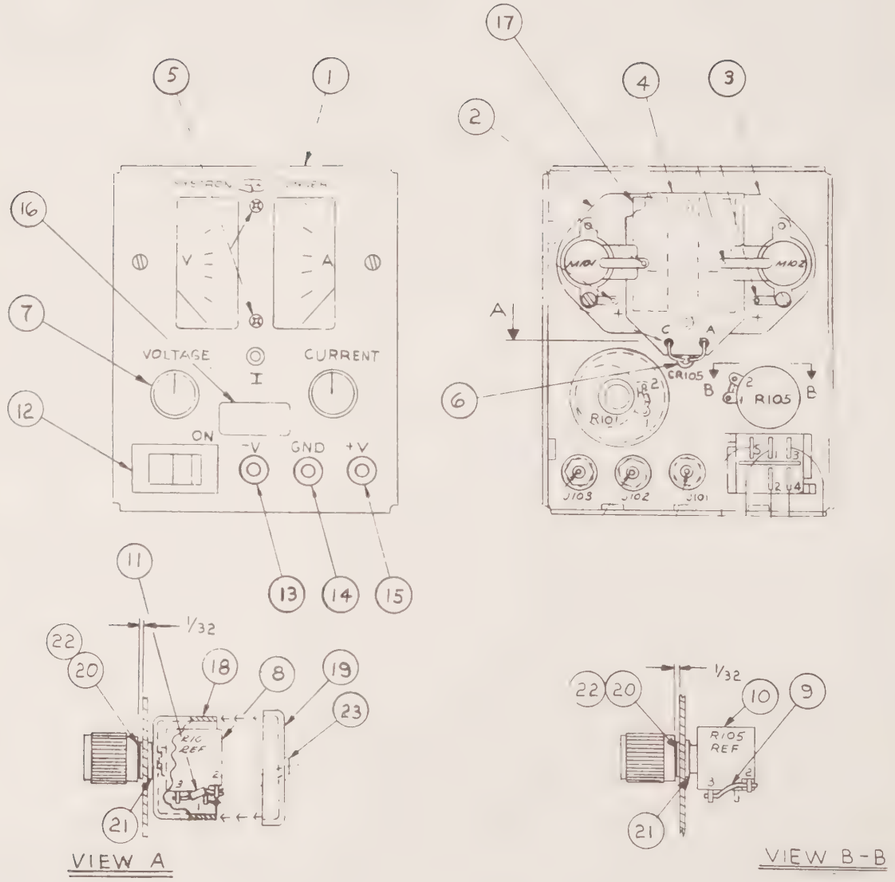


FIGURE 6-8
MODEL HHB 20-2 PANEL ASSEMBLY
#06525202 Rev C

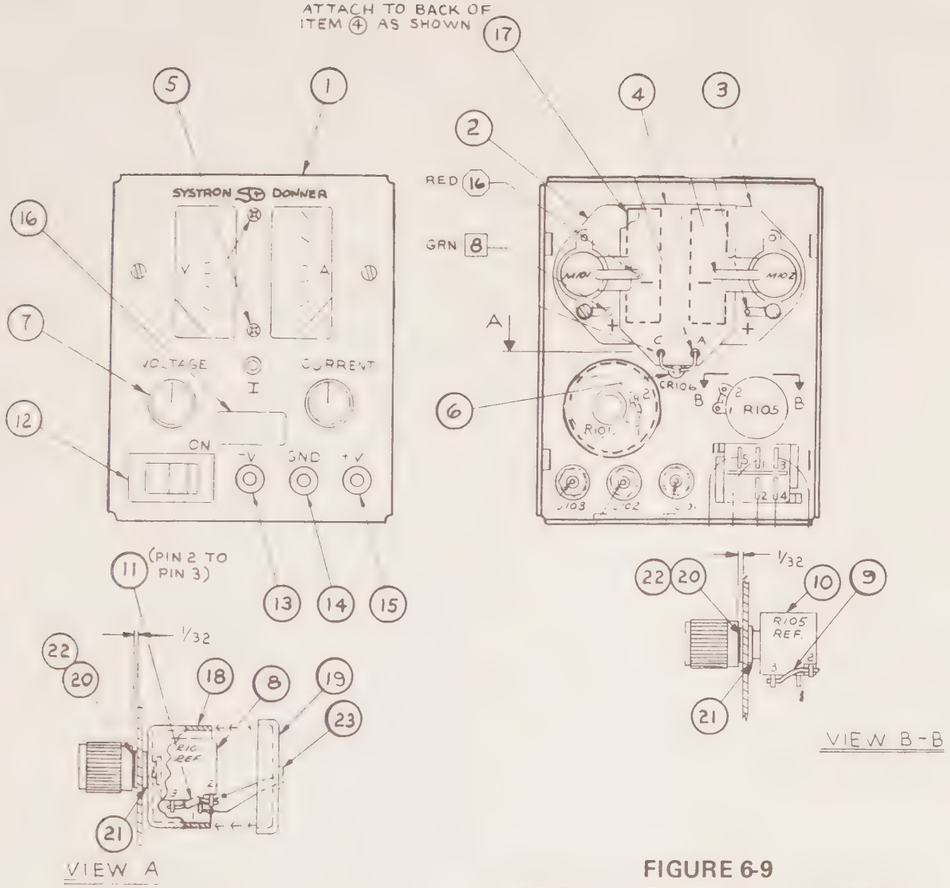


FIGURE 6-9
MODEL HHB 50-1 PANEL ASSEMBLY
#06525203 Rev C

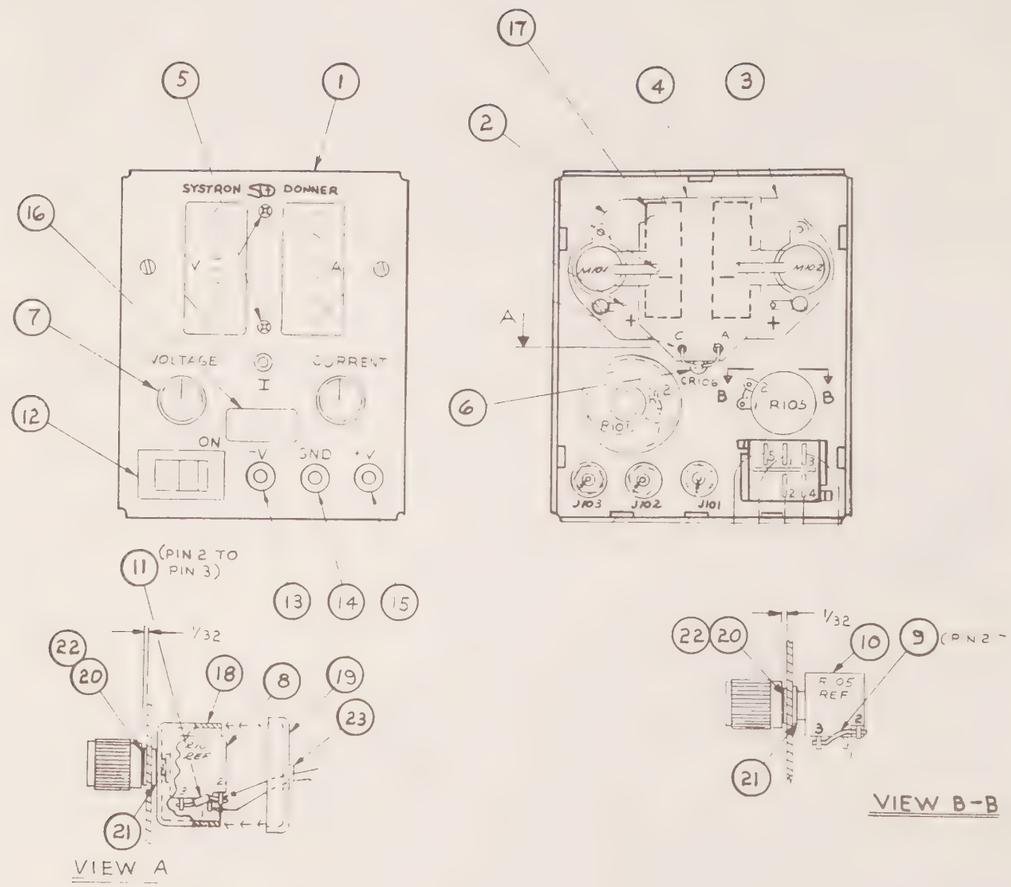


FIGURE 6-10
MODEL HHB 150-.3 PANEL ASSEMBLY
#06525204 Rev C

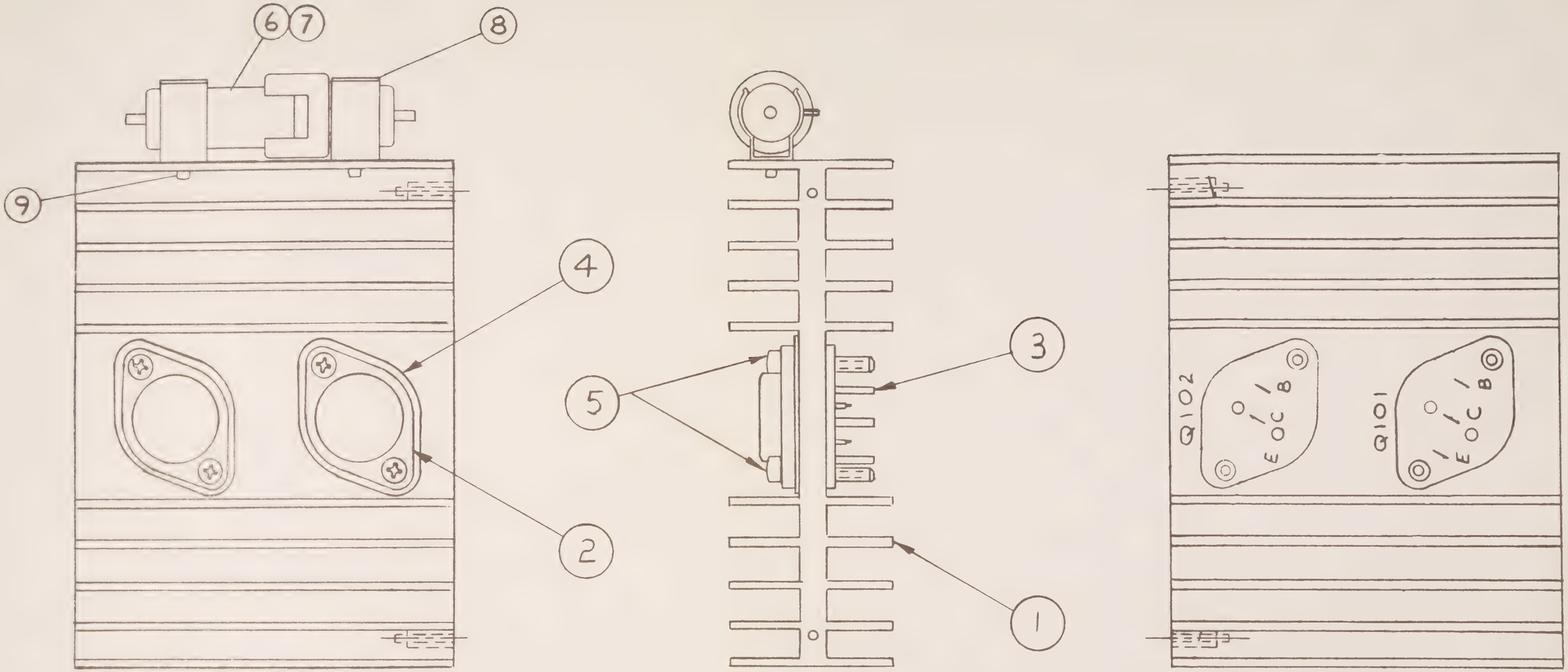
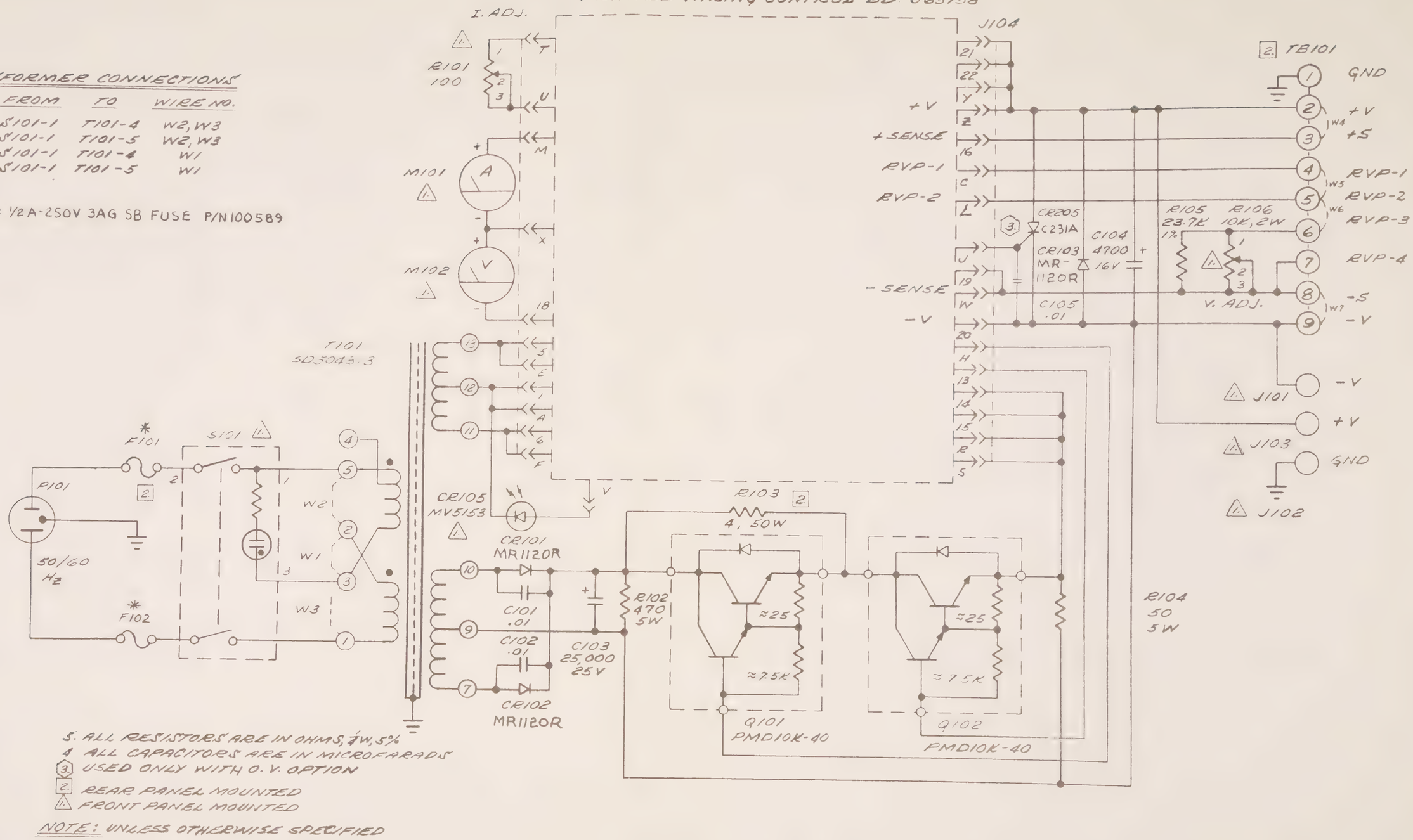


FIGURE 6-11
HHB SERIES HEAT SINK ASSEMBLY
#06525403 Rev B

TRANSFORMER CONNECTIONS

VOLTAGE	FROM	TO	WIRE NO.
100	S101-1	T101-4	W2, W3
115/120	S101-1	T101-5	W2, W3
208/220	S101-1	T101-4	W1
230/240	S101-1	T101-5	W1

* FOR E-OPTION: 1/2A-250V 3AG SB FUSE P/N100589



5. ALL RESISTORS ARE IN OHMS, ¼W, 5%
4 ALL CAPACITORS ARE IN MICROFARADS
(3) USED ONLY WITH O. V. OPTION
[2] REAR PANEL MOUNTED
⚠1 FRONT PANEL MOUNTED

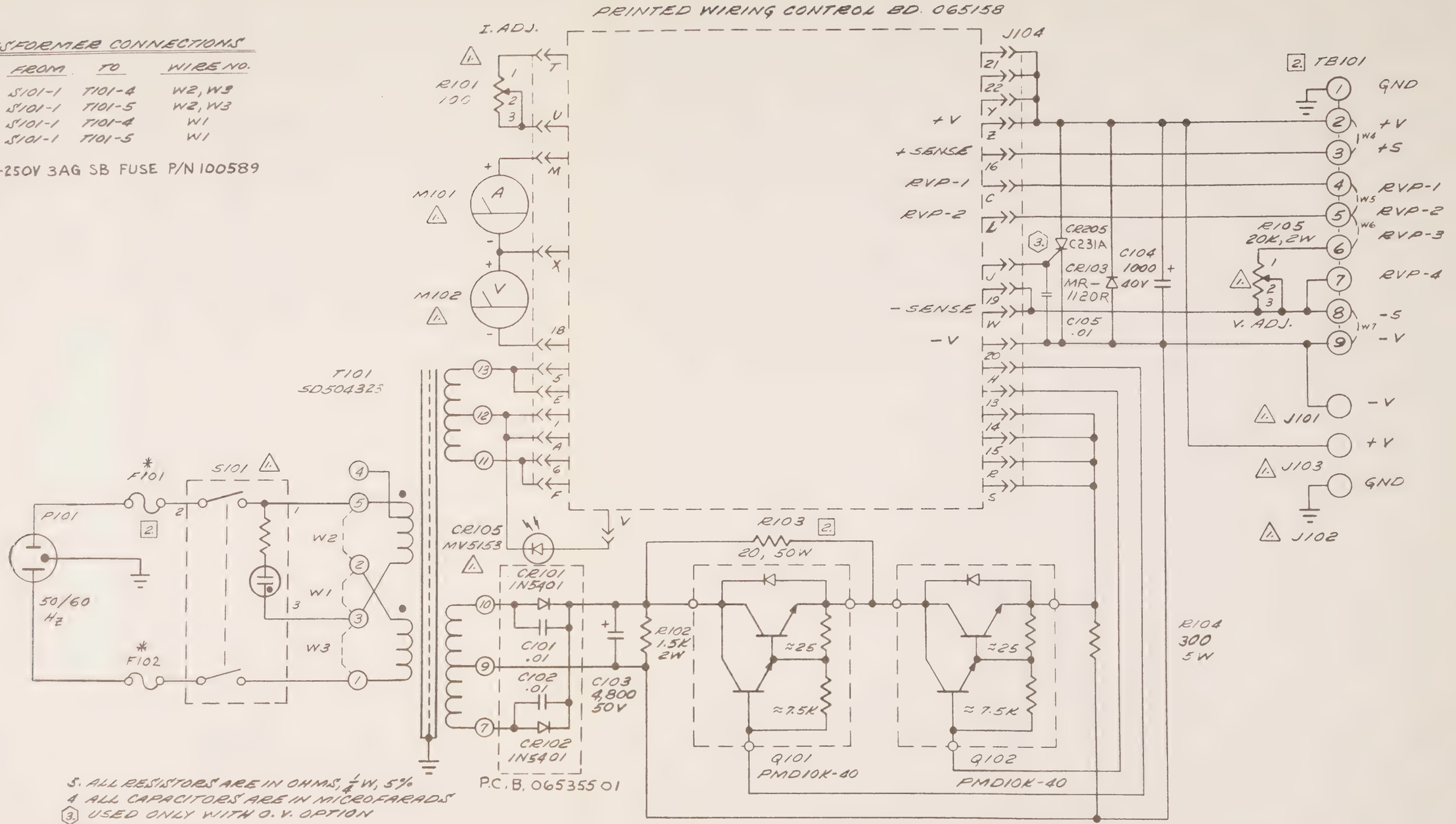
NOTE: UNLESS OTHERWISE SPECIFIED

FIGURE 6-12
MODEL HHB 6-5 CHASSIS ASSEMBLY
SCHEMATIC #7-06524801 Rev B

TRANSFORMER CONNECTIONS

VOLTAGE	FROM	TO	WIRE NO.
100	S101-1	T101-4	W2, W3
115/120	S101-1	T101-5	W2, W3
208/220	S101-1	T101-4	W1
230/240	S101-1	T101-5	W1

* FOR E-OPTION: Y2A-250V 3AG SB FUSE P/N 100589



3. ALL RESISTORS ARE IN OHMS, ¼ W, 5%
4 ALL CAPACITORS ARE IN MICROFARADS
(3) USED ONLY WITH O. V. OPTION
(2) REAR PANEL MOUNTED
(1) FRONT PANEL MOUNTED

NOTE: UNLESS OTHERWISE SPECIFIED

FIGURE 6-13
MODEL HHB 20-2 CHASSIS ASSEMBLY
SCHEMATIC #7-06524802 Rev B

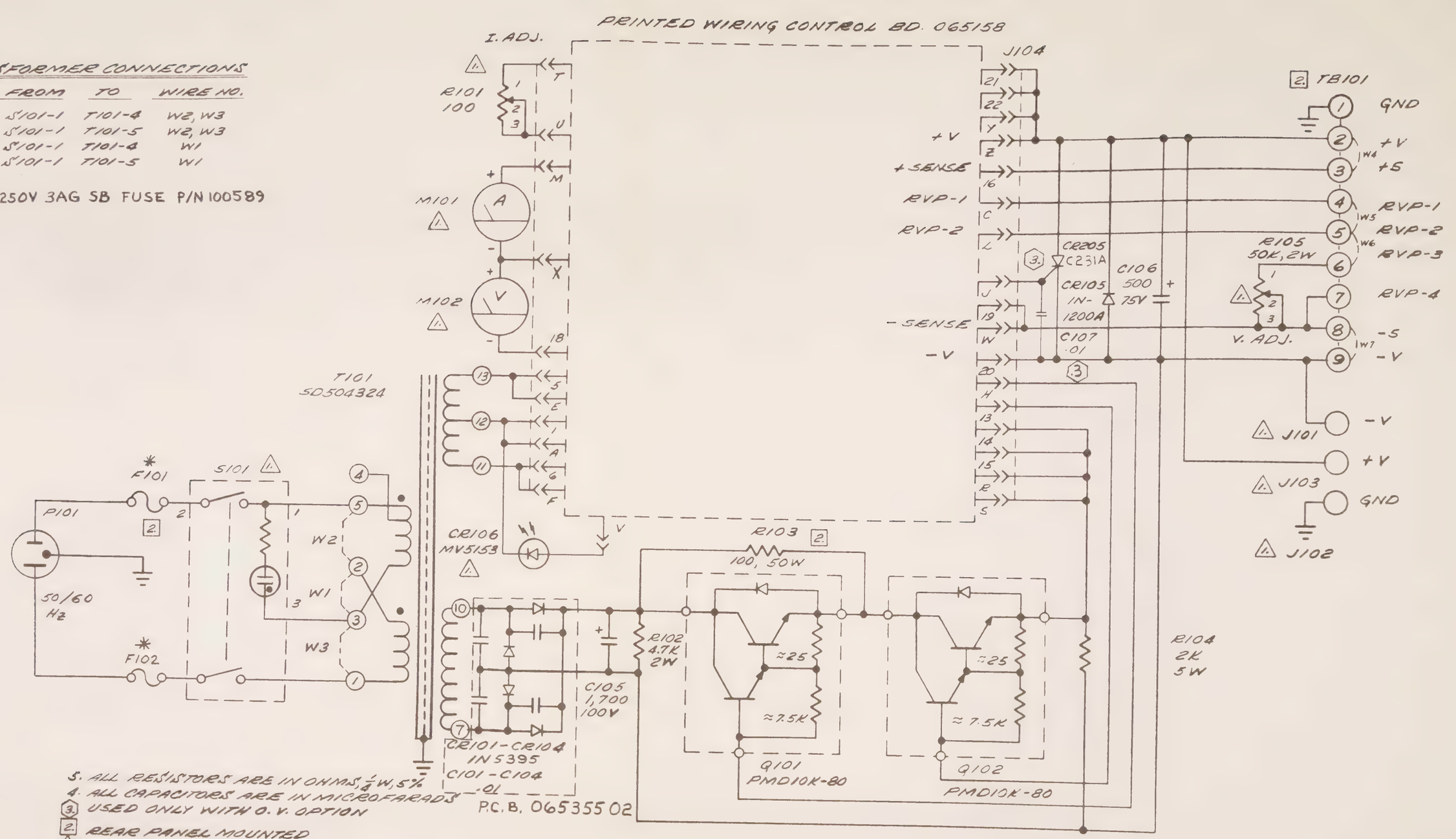
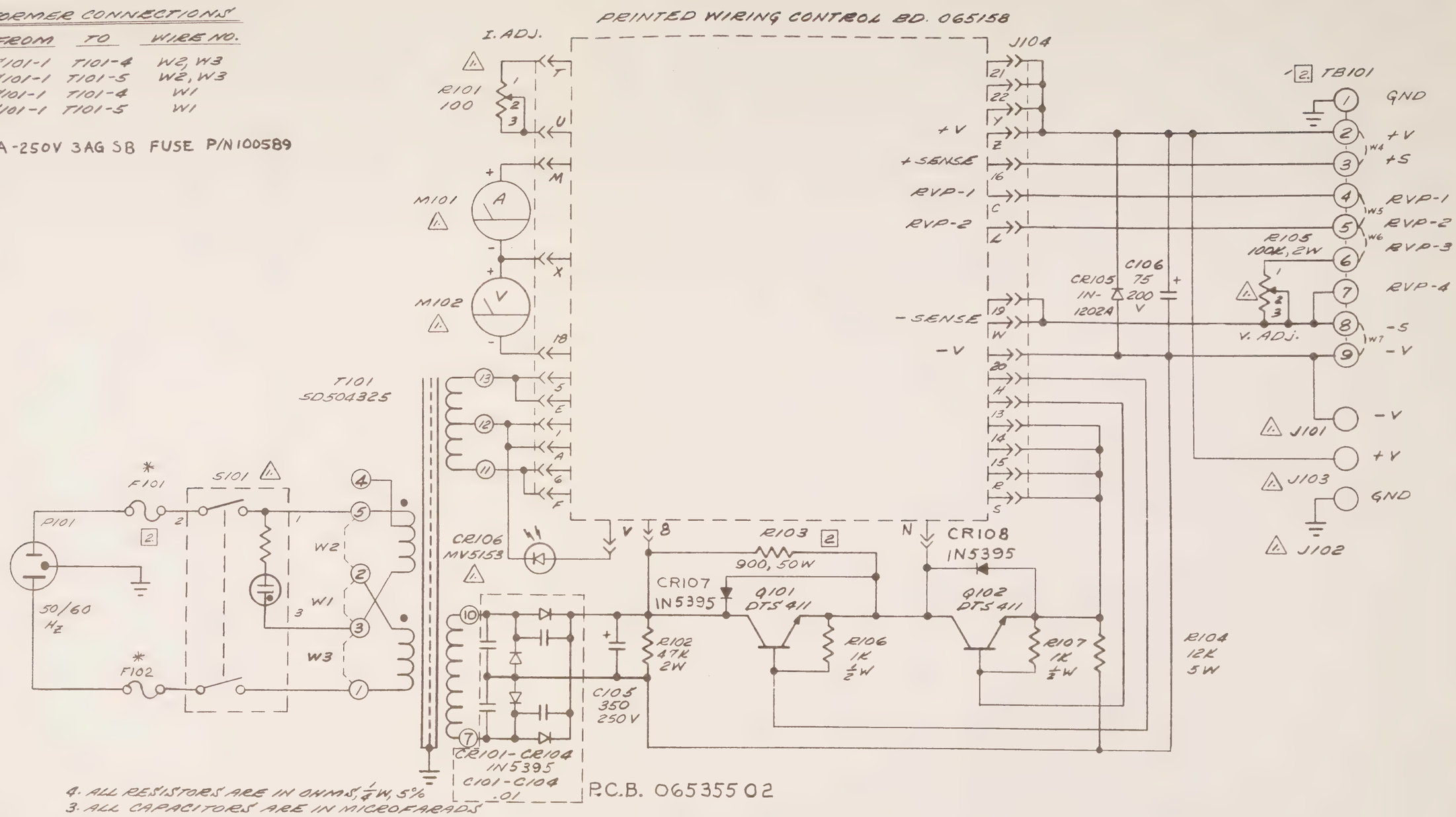


FIGURE 6-14
MODEL HHB 50-1 CHASSIS ASSEMBLY
SCHEMATIC #7-06524803 Rev B

TRANSFORMER CONNECTIONS

VOLTAGE	FROM	TO	WIRE NO.
100	S101-1	T101-4	W2, W3
115/120	S101-1	T101-5	W2, W3
208/220	S101-1	T101-4	W1
230/240	S101-1	T101-5	W1

* FOR E-OPTION: 1/2A-250V 3AG SB FUSE P/N100589



4. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
3. ALL CAPACITORS ARE IN MICROFARADS

2. REAR PANEL MOUNTED
1. FRONT PANEL MOUNTED

NOTE: UNLESS OTHERWISE SPECIFIED

FIGURE 6-15
MODEL HHB 150-.3 CHASSIS ASSEMBLY
SCHEMATIC #7-06524804 Rev B

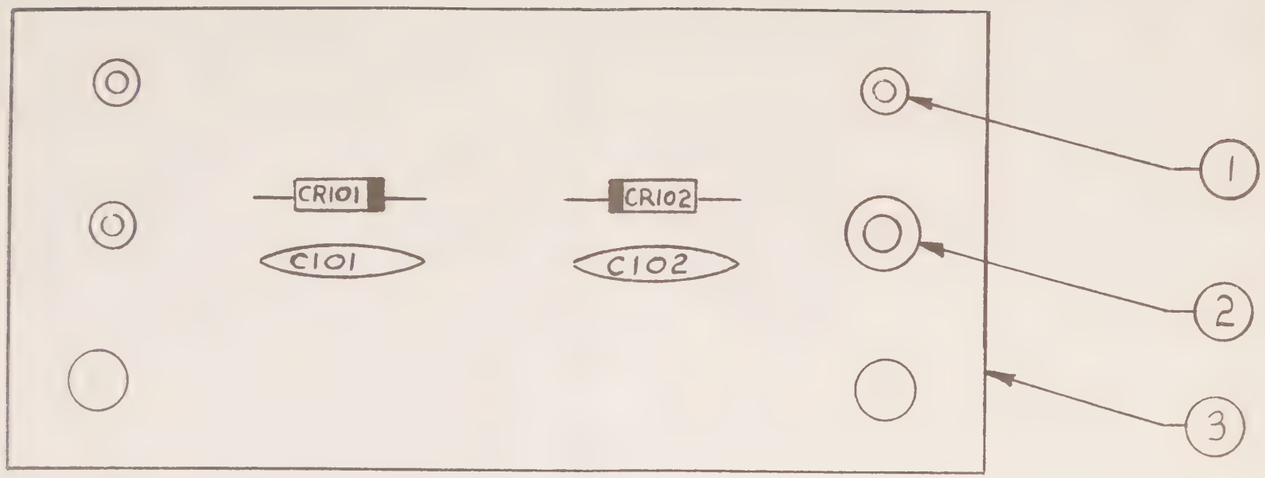


FIGURE 6-16
DIODE ASSEMBLY
#06535501 Rev A

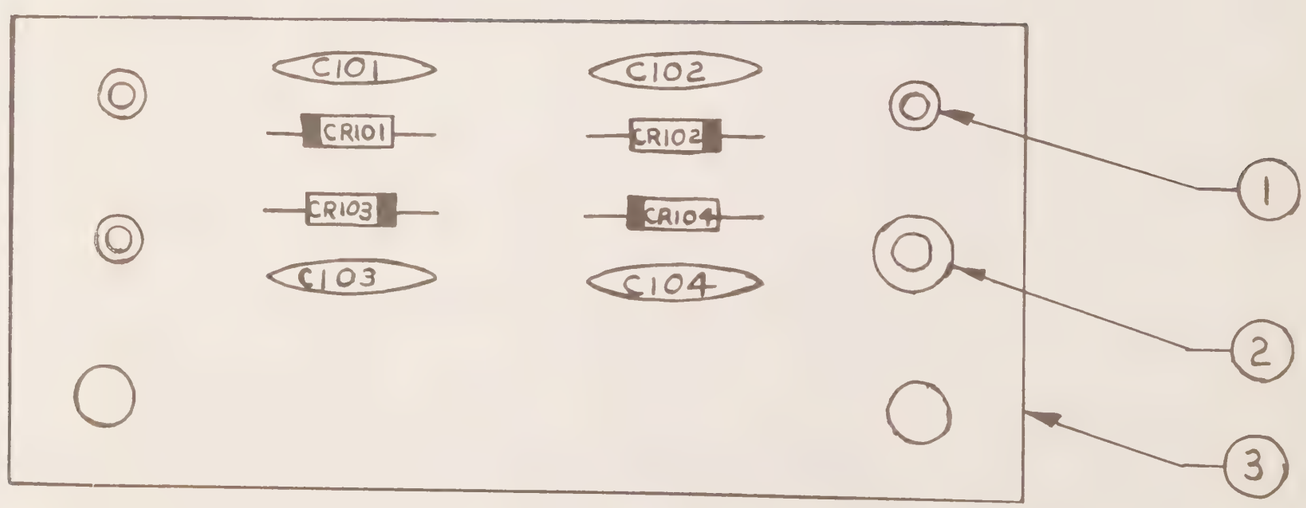
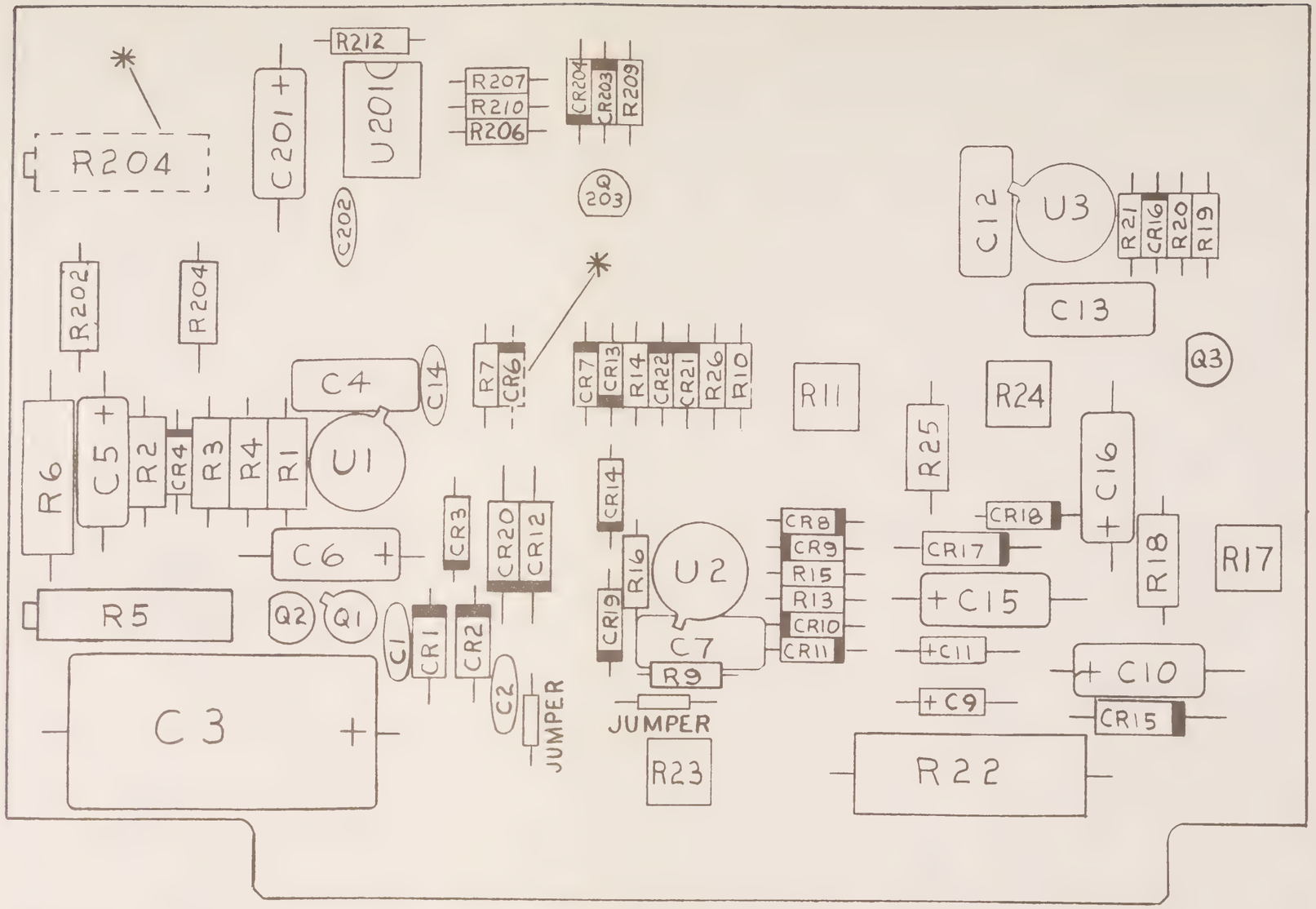
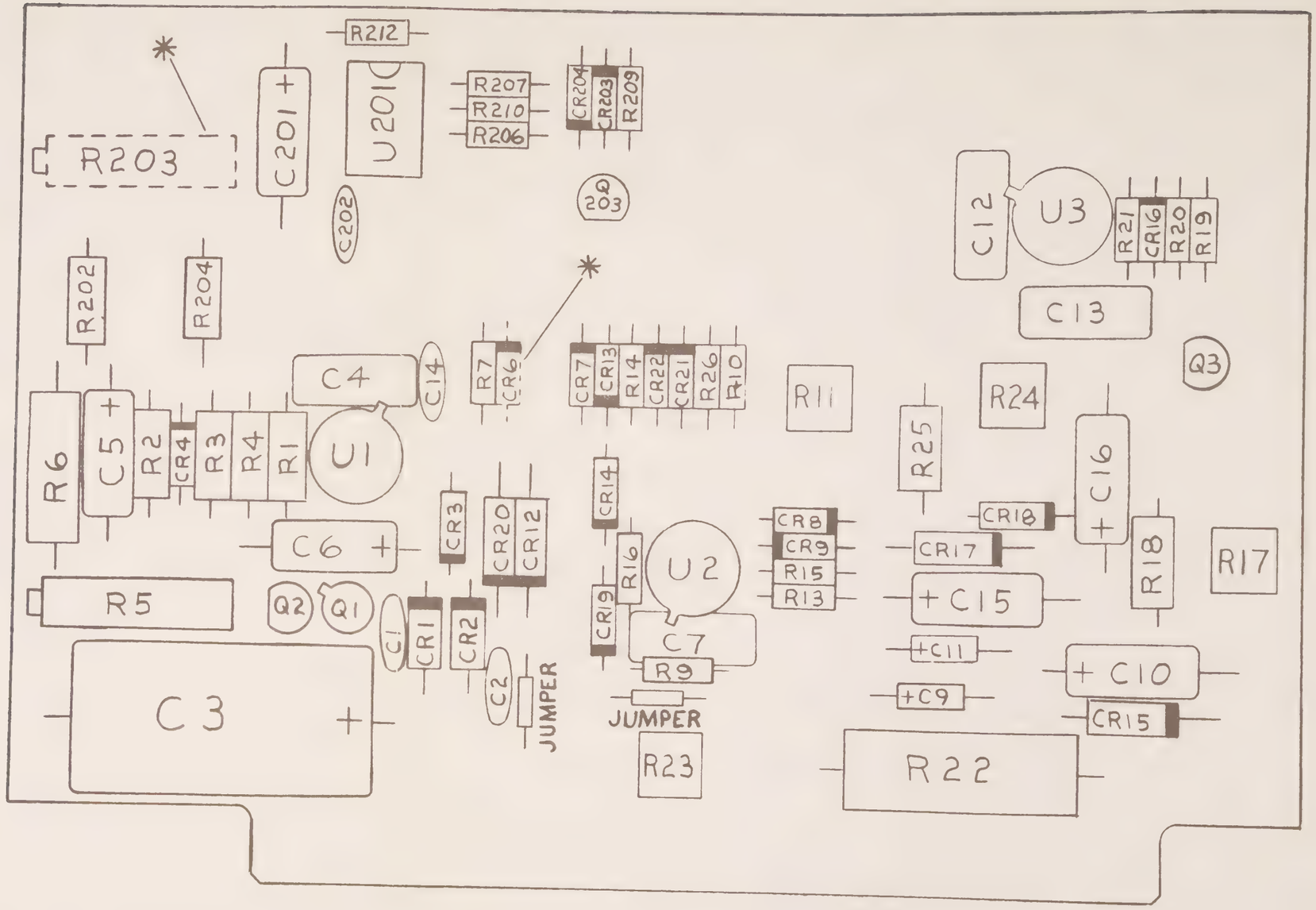


FIGURE 6-17
DIODE ASSEMBLY
#06535502 Rev A



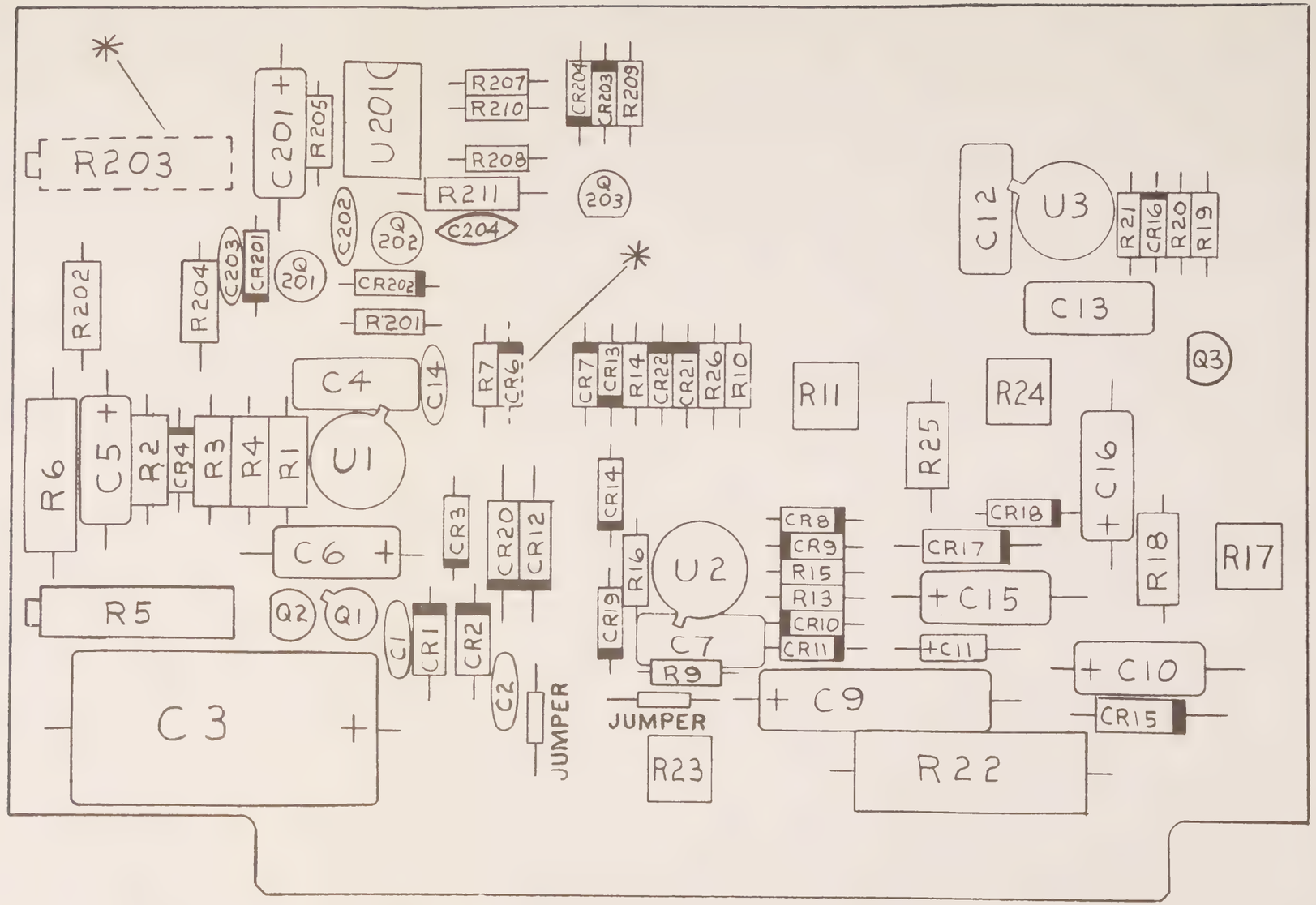
*DOTTED LINES INDICATE PARTS TO BE ADDED FOR O.V. OPTION

FIGURE 6-18
HHB 6-5 CONTROL BOARD
PC ASSEMBLY #06515802



*DOTTED LINES INDICATE PARTS TO BE ADDED FOR O.V. OPTION

FIGURE 6-19
HHB 20-2 CONTROL BOARD
PC ASSEMBLY #06515804



*DOTTED LINES INDICATE PARTS TO BE ADDED FOR O.V. OPTION

FIGURE 6-20
HHB 50-1 CONTROL BOARD
PC ASSEMBLY #06515806

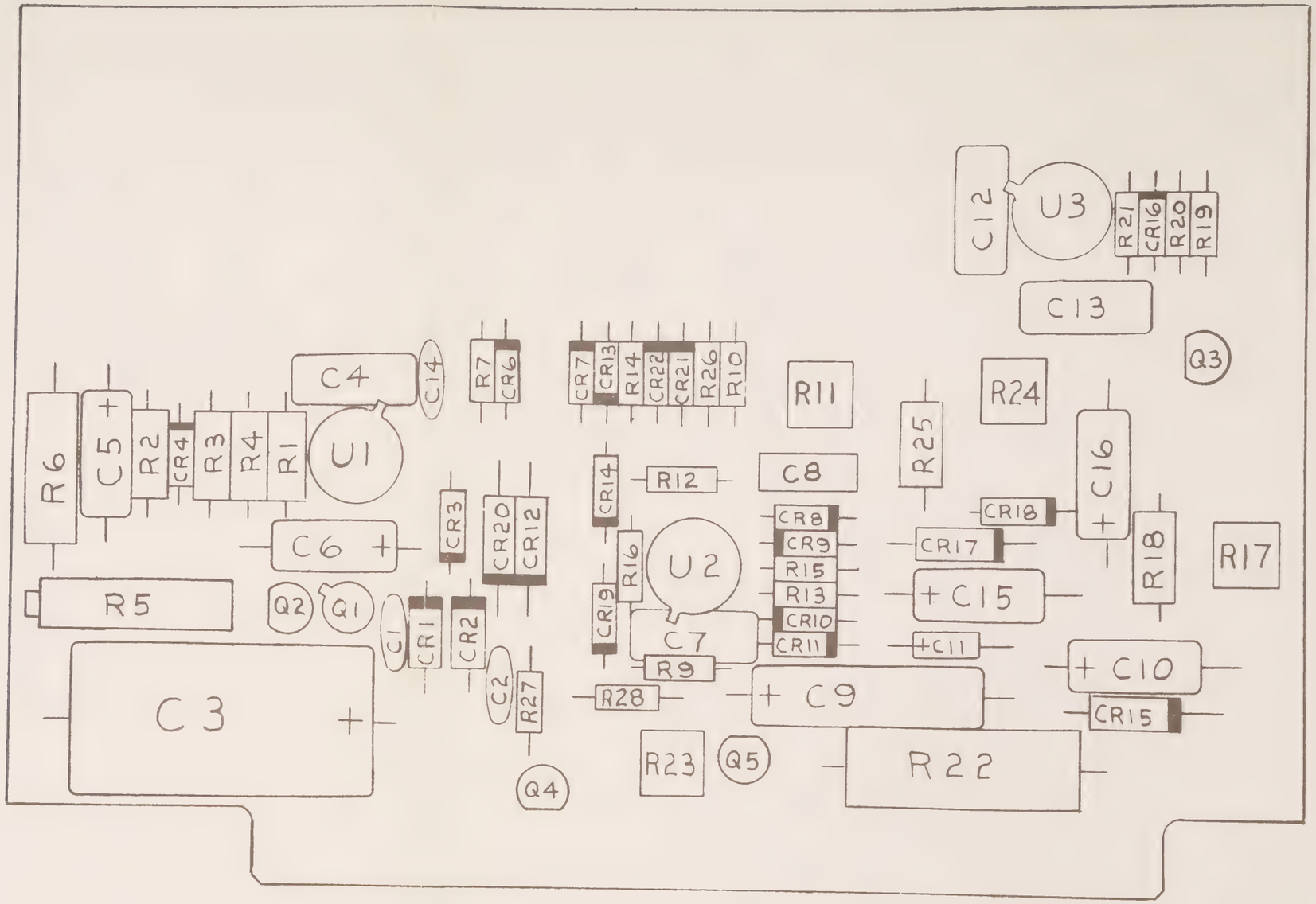
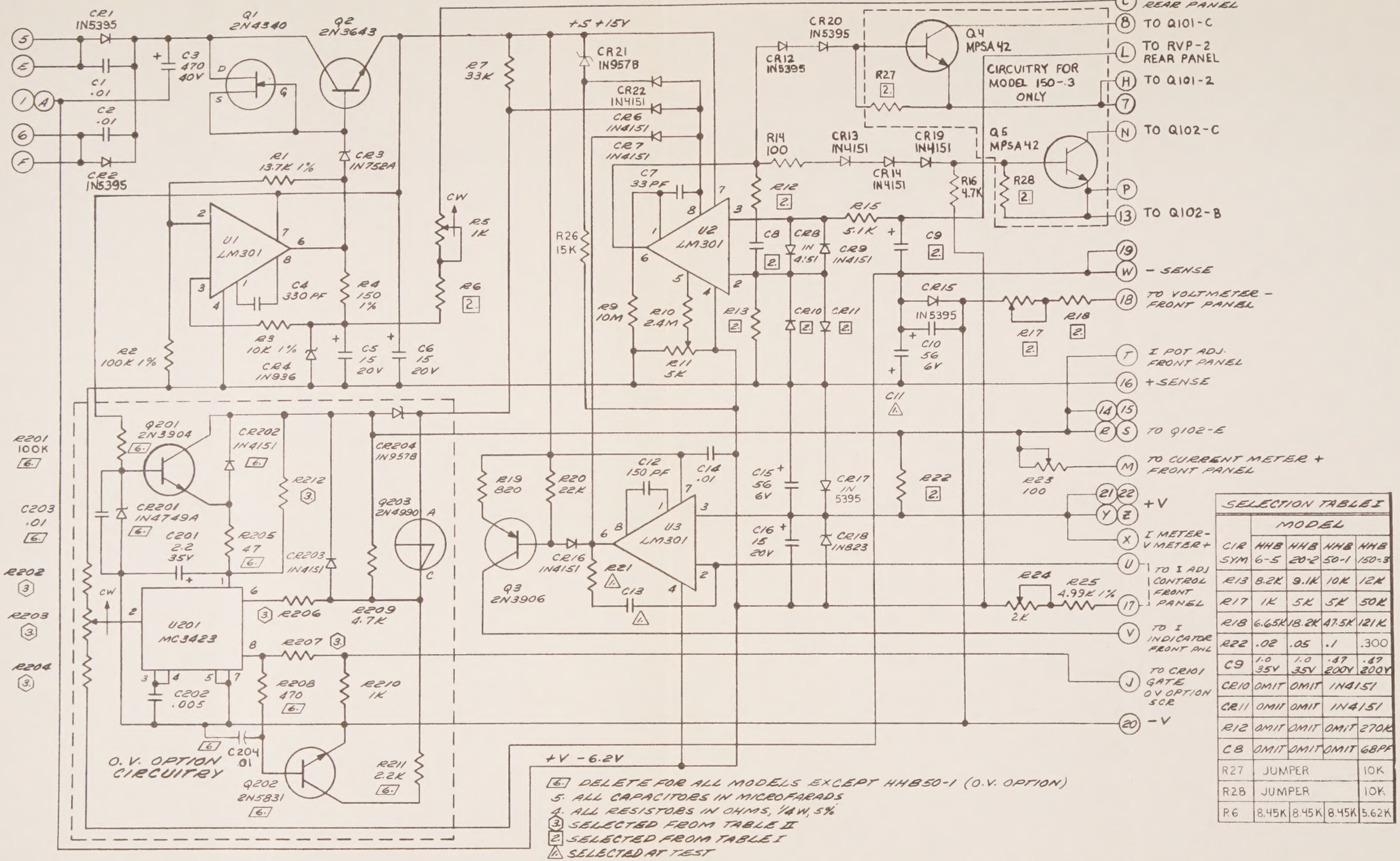


FIGURE 6-21
HHB 150-.3 CONTROL BOARD
PC ASSEMBLY #06515807



SELECTION TABLE I				
	MODEL			
CIR SYM	HHB 6-5	HHB 20-2	HHB 50-1	HHB 150-3
R13	8.2K	9.1K	10K	12K
R17	1K	5K	5K	50K
R18	6.65K	18.2K	47.5K	121K
R22	.02	.05	.1	.300
C9	1.0 35V	1.0 35V	.47 200V	.47 200V
CR10	OMIT	OMIT	IN4151	
CR11	OMIT	OMIT	IN4151	
R12	OMIT	OMIT	OMIT	270K
C8	OMIT	OMIT	OMIT	68PF
R27	JUMPER			10K
R28	JUMPER			10K
R6	8.45K	8.45K	8.45K	5.62K

SELECTION TABLE II O.V. OPTION						
MODEL	R202	R203	R204	R206	R207	R212
HHB 6-5	2.67K	2K	2.21K	1K	27	47
HHB 20-2	7.50K	10K	2.00K	1K	47	47
HHB 50-1	6.65K	10K	750	OMIT	47	OMIT
HHB 150-3	O.V. OPTION NOT AVAILABLE					

6. DELETE FOR ALL MODELS EXCEPT HHB 50-1 (O.V. OPTION)
5. ALL CAPACITORS IN MICROFARADS
4. ALL RESISTORS IN OHMS, 1/4W, 5%
3. SELECTED FROM TABLE II
2. SELECTED FROM TABLE I
Δ SELECTED AT TEST

NOTE: UNLESS OTHERWISE SPECIFIED

FIGURE 6-22 HHB SERIES CONTROL BOARD SCHEMATIC #7-065247 Rev C

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